



UL 22

STANDARD FOR SAFETY

Amusement and Gaming Machines

UL Standard for Safety for Amusement and Gaming Machines, UL 22

Sixth Edition, Dated May 30, 2008

Summary of Topics

This revision to ANSI/UL 22 dated August 16, 2023 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

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

The requirements are substantially in accordance with Proposal(s) on this subject dated May 26, 2023.

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UL 22

Standard for Amusement and Gaming Machines

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Sixth Edition

May 30, 2008

This ANSI/UL Standard for Safety consists of the Sixth Edition including revisions through August 16, 2023.

The most recent designation of ANSI/UL 22 as a Reaffirmed American National Standard (ANS) occurred on August 16, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover electrical, electronic, and electromechanical commercial amusement and gaming machines and accessories that are intended to be used in accordance with the National Electrical Code, NFPA 70.

1.2 Amusement and gaming machines as covered by this standard are intended for indoor use only, except that they will be investigated for outdoor use or use in a protected location if so designated by the manufacturer.

1.3 These requirements do not cover coin-operated sound-recording and -reproducing machines or carnival rides.

2 Components

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

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

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

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

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

3 Units of Measurement

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

3.2 Unless indicated otherwise, all voltage and current values mentioned in this standard are root-mean-square (rms).

4 Undated References

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

5 Terminology

5.1 A requirement in this Standard that applies only to a specific type of amusement or gaming machine is so identified by a specific reference in that requirement to the type involved. Absence of such specific

reference or use of the term "appliance" indicates that the requirement applies to all amusement and gaming machines covered by this standard.

6 Glossary

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

6.2 **BARRIER** – A part inside an enclosure that reduces the accessibility to a part that involves a risk of electric shock or injury to persons.

6.3 **CABINET** – A part outside the enclosure that houses or covers only portions of the appliance that do not involve a risk of fire, electric shock, or injury to persons.

6.4 **CONTINUOUS DUTY MOTOR** – A motor that is intended to operate unattended for a period of 3 hours or more while under load.

6.5 **ENCLOSURE** – A housing of an appliance that reduces the accessibility to a part that may involve a risk of fire or electric shock. An enclosure can also prevent access to a part that involves a risk of injury to persons when evaluated in accordance with Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts, Section [10](#).

6.6 **FIELD-WIRING TERMINAL** – A terminal to which a supply or other wire may be connected by service personnel in the field, unless the wire is provided as part of the appliance and a pressure terminal, connector, soldering lug, soldered loop, crimped eyelet, or other means for making the connection is factory-assembled to the wire.

6.7 **GUARD** – A part outside of the enclosure that reduces the accessibility to a component that involves a risk of injury to persons when evaluated in accordance with Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts, Section [10](#).

6.8 **INDOOR LOCATION** – Inside a building where not normally subjected to the effects of weathering.

6.9 **MAINTENANCE AREA** – An area where access can only be gained by the use of a maintenance key.

6.10 **MAINTENANCE KEY** – Key or other means which provides access to the maintenance area but does not permit access to the service area.

6.11 **MAINTENANCE PERSON** – The person who performs routine maintenance such as the setting of controls and other minor adjustments. Some examples of maintenance are:

a) Replacement of lamps and fuses and resetting of circuit breakers located in a user-access area unless the lamps, fuses, or circuit breakers are marked to indicate replacement or resetting only by service personnel.

b) The making of routine operating adjustments including, but not limited to, cleaning the machine, clearing the coin mechanism of jams, removing coins or price changing.

6.12 **NEON TUBE** – A small diameter glass cylinder, evacuated of air and filled with an inert gas such as neon, which emits light when excited by a high voltage neon transformer or power supply.

6.13 **OUTDOOR LOCATION** – An area that is open and subjected to the full effects of weathering.

6.14 **PRIMARY CIRCUIT** – Wiring and components that are conductively connected to a branch circuit.

6.15 **PROTECTED LOCATION** – An area that is partially protected from the effects of weathering through the use of a roof, canopy, marquee, or the like.

6.16 **SAFETY CIRCUIT** – Any primary or secondary circuit that is relied upon to reduce the risk of fire, electric shock, high current levels of electrical energy, or injury to persons. For example, in some applications, an interlock circuit is considered to be a safety circuit.

6.17 **SECONDARY CIRCUIT** – A circuit supplied from a secondary winding of an isolating transformer.

6.18 **SERVICE AREA** – An area where access cannot be gained by the use of a maintenance key alone.

6.19 **SERVICE PERSON** – An authorized person who may periodically open an appliance to repair or maintain electrical or mechanical components. Some examples of servicing are:

- a) The installation of accessories or conversion kits by means of attachment plugs and receptacles or by means of other separable connectors, and
- b) The replacement of tapes, discs, or program boards.

6.20 **TOOL** – A screwdriver, coin, dedicated key, or any other object that may be used to operate a screw, latch, or similar fastening means.

6.21 **USER** – The player or participant of the amusement or gaming machine.

6.22 **USER AREA** – All external surface areas, all internal areas that can be entered without the use of a maintenance key or tools, and all areas that the user is instructed to enter regardless of whether or not tools are needed to gain access.

CONSTRUCTION

7 General

7.1 Only materials that are intended for the particular use shall be used in amusement and gaming machines.

7.2 When the deterioration or breakage of any part that contains, conducts, or otherwise contacts a liquid could result in a risk of fire, electric shock, or injury to persons, the part shall be of a material resistant to corrosion by the liquid to be used therein and shall have the strength to withstand the pressures involved.

8 Frame and Enclosure

8.1 General

8.1.1 An enclosure, guard, or barrier shall have the strength and rigidity to resist the abuses likely to be encountered during intended use of the appliance without increasing the risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings to less than required, or the loosening, displacement, or exposure of parts, or other serious defects.

8.1.2 An enclosure, guard, or barrier of an appliance shall be complete, or completion of the enclosure, guard, or barrier shall be attained when an appliance is installed for operation.

8.1.3 A required enclosure, guard, or barrier shall be capable of being removed and replaced with a minimum of effort when removal is necessary to service the protected parts.

8.1.4 The strength and rigidity is to be evaluated by the tests in:

- a) [45.2.1](#)– [45.2.3](#) and [45.4.1](#) for a nonmetallic enclosure or guard;
- b) [45.3.1](#)– [45.4.1](#) for a metal enclosure or guard; and
- c) [45.4.1](#) for a barrier that is accessible to a maintenance person.

The enclosures, guards, and barriers of an appliance intended for outdoor use shall be tested for resistance to the atmospheric effects of rain and sunlight.

8.1.5 A handle or handles intended for lifting or carrying an appliance shall comply with the Handle Test, Section [40](#).

8.1.6 An enclosure may be provided with a door for maintenance access when:

- a) The door is hinged or otherwise secured such that it is unlikely to be detached when opened for maintenance;
- b) The door is intended to be closed and latched during normal operation; and
- c) The appliance complies with the accessibility requirements in Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts, Section [10](#), when the door is open.

8.2 External materials

8.2.1 Materials such as steel, aluminum, wood, particle board, composite materials, glass, and other similar materials shall be used for the enclosure, guard, or cabinet of an appliance. Glass shall be heat-resistant, tempered, wired, or laminated. See [8.2.2](#) for small parts requirements.

Exception No. 1: Other materials may be used for part or all of an enclosure when they comply with the requirements in [8.1.4](#), [8.2.3](#), and the Standard for Polymeric Materials– Use in Electrical Equipment Evaluations, UL 746C.

Exception No. 2: Materials with a flammability rating of HB, V-2, V-1, V-0, or 5V in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, or material determined to be equivalent may be used for part or all of a cabinet. See also [8.2.3](#).

Exception No. 3: Materials that are classed HB, V-2, V-1, V-0, or 5V in accordance with UL 94, or an equivalent material may be used as guards when they comply with [8.1.4](#), [8.2.3](#), and [45.1](#) – [45.3](#).

Exception No. 4: Ordinary glass may be used when the optical or flatness requirement precludes the use of heat-resistant, tempered, wired, or laminated glass.

8.2.2 The flammability requirements in Exception No. 1 to [8.2.1](#) does not apply to small parts. For the purpose of these requirements, a small part is defined as one that complies with both of the following items:

- a) A small part shall not be part of the appliance enclosure, or enclose live parts or be used to reduce the likelihood of electric shock.
- b) The location of a small part is such that it cannot propagate flame from one area to another or act as a bridge between a possible source of ignition and other ignitable parts.

8.2.3 An external surface of combustible material having an exposed area greater than 10 square feet (0.93 m²) or a single dimension larger than 6 feet (1.83 m) shall have a flame spread index of 200 or less when tested in accordance with:

- a) The Standard for Test for Surface Burning Characteristics of Building Materials, UL 723, or
- b) The radiant-panel furnace method in the Standard Test Method for Surface Flammability of Materials Using a Radiant-Heat Energy Source, ASTM E162.

Exception: The materials described in (a) – (b) below are not required to be tested:

- a) 1/2-inch (12.7-mm) or 3/4-inch (19.0-mm) thick plywood with no coating;
- b) 1/2-inch (12.7-mm) or 3/4-inch (19.0-mm) thick plywood with a latex paint coating; and
- c) 3/4-inch (19.0-mm) thick plywood, particle board or medium density fiberboard (MDF) covered with a melamine laminate using a melamine resin adhesive.

8.2.4 The flame-spread index in [8.2.3\(b\)](#) is the average value based on tests on six specimens representative of the wall thickness used, with no single specimen value greater than 300.

8.2.5 A material with a flame-spread index higher than specified in [8.2.3](#) may be used as the exterior finish or covering on any portion of the enclosure, guard, or cabinet if the flame-spread index of the combination of the base material and finish or covering complies with [8.2.3](#).

8.2.6 The size limitations mentioned in [8.2.3](#) refer to the exposed surface area of a single unbroken section. If two sides of a single piece are exposed, only the larger side is to be considered in computing the area.

8.2.7 A conductive coating applied to a surface (such as the inside surface of a cover or an enclosure) shall comply with the appropriate requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: When flaking or peeling of the coating will not result in the reduction of spacings or the bridging of live parts that may present a risk of fire or electric shock, then the coating need not comply with UL 746C.

8.3 Enclosure bottom openings

8.3.1 The enclosure of an appliance shall prevent molten metal, burning insulation, flaming particles, or the like from falling on combustible materials, including the surface upon which the appliance is supported.

8.3.2 The requirement in [8.3.1](#) necessitates the use of a barrier or pan of noncombustible material:

- a) Under a motor unless:
 - 1) The structural parts of the motor or of the appliance provide a barrier that has been determined to be equivalent;
 - 2) The overload protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the appliance when the motor is energized under each of the following fault conditions:
 - i) Open main winding,
 - ii) Open auxiliary winding, and

iii) Starting switch short-circuited; or

3) The motor is provided with a thermal motor protector – a protective device that is sensitive to temperature and current – that will prevent the temperature of the motor windings from exceeding:

i) 125°C (257°F) when the motor is running at the maximum load at which it can operate without causing the protector to cycle and

ii) 150°C (302°F) with the rotor of the motor locked.

b) Under wire, unless it is flame-retardant such as thermoplastic- or neoprene-insulated wires.

c) Under a switch, a relay, a solenoid, a transformer, or the like unless it can be shown that malfunction of the component would not result in a risk of fire.

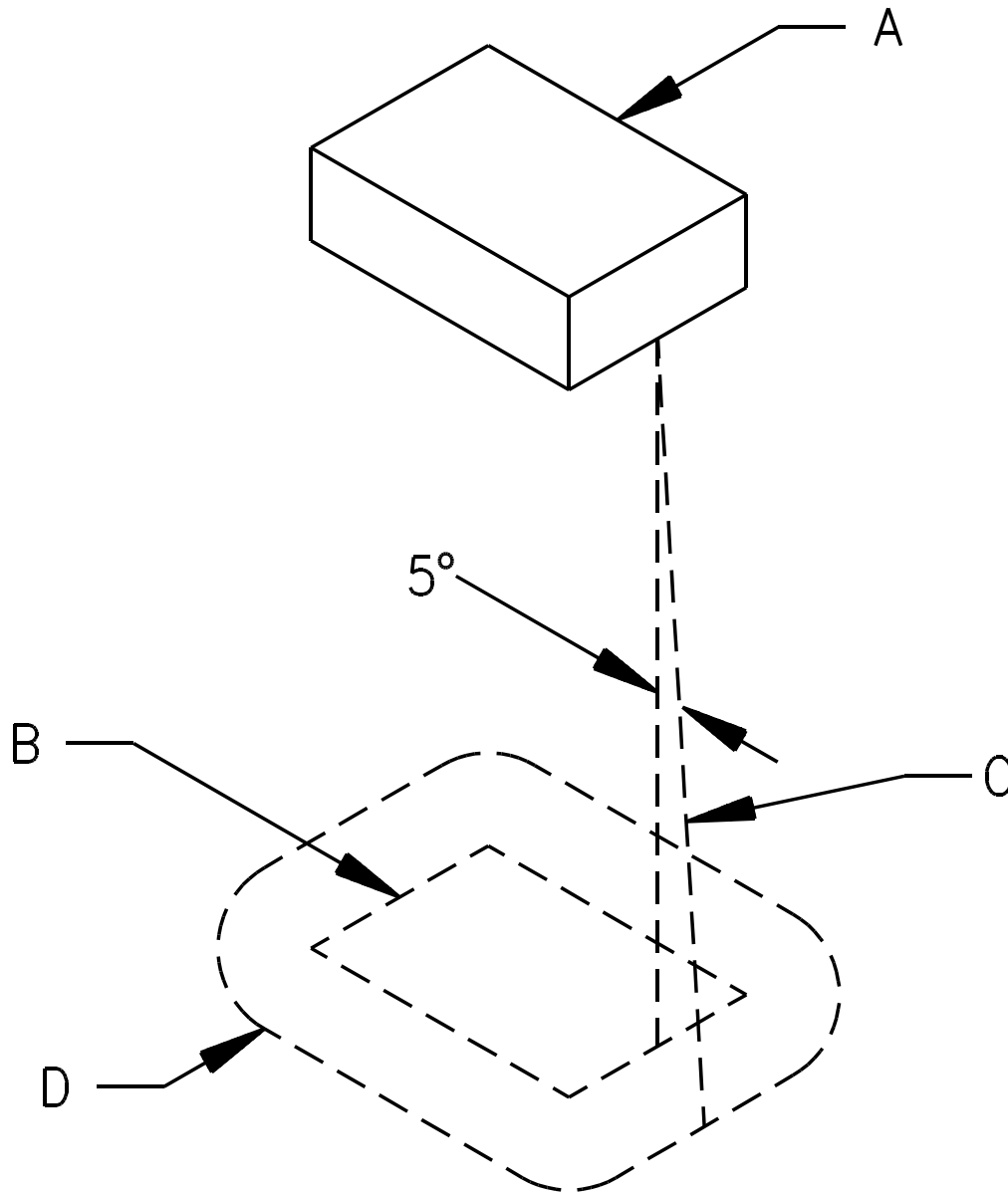
8.3.3 The barrier mentioned in [8.3.2](#) shall be:

a) Horizontal,

b) Located as illustrated in [Figure 8.1](#), and

c) Have an area in accordance with that figure.

Figure 8.1
Location and extent of barrier



SA0604-1

A – Region to be shielded by barrier. This will consist of the entire component if it is not otherwise shielded and will consist of the unshielded portion of a component that is partially shielded by the component enclosure or by a barrier that has been determined to be equivalent.

B – Projection of outline of component on horizontal plane.

C – Inclined line that traces out minimum area of barrier. The line is always tangent to the component, 5 degrees from the vertical, and oriented so that the area traced out on a horizontal plane is maximum.

D – Location (horizontal) and minimum area for barrier. The area is that included inside the line of intersection traced out by the inclined line C and the horizontal plane of the barrier.

8.3.4 Materials used for barriers have a flammability rating of V-2 or less in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94. Additionally, barriers that are accessible to a maintenance person shall comply with the requirements in [8.1.4](#) and [45.1–45.3](#).

Exception: Barrier materials need not have a flammability rating of V-2 or less when they are one of the materials mentioned in [8.2.1](#) or comply with Exception Nos. 1 – 4 to [8.2.1](#).

8.4 Medium- and high-pressure lamps

8.4.1 A medium-pressure lamp shall be enclosed or guarded to protect against breakage due to external forces or impacts.

8.4.2 A high-pressure lamp shall be enclosed so that an explosion of the lamp will be contained. See [54.19](#) for high-pressure lamp caution marking.

8.4.3 High-pressure lamps may be exploded within the enclosure of the appliance to determine compliance with [8.4.2](#).

8.4.4 With reference to the requirements in [8.4.1 – 8.4.3](#), a medium-pressure lamp is considered to be one in which the contained atmospheric energy (CAE) is less than 5 joules and greater than 0.5 joules and a high-pressure lamp is considered to be one in which the CAE equals or exceeds 5 joules when defined as follows:

$$CAE = 0.15 (PC - PE)V$$

in which:

PC is the contained pressure in atmospheres, measured at 50°C or less;

PE is the external pressure in atmospheres, measured at 50°C or less; and

V is the volume in cubic centimeters.

8.5 Air filters

8.5.1 An air filter for use in a cooling system shall comply with the Standard for Air Filter Units, UL 900, or shall be constructed of materials with a flammability rating of V-2 or less in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception No. 1: Air filters used in a closed system need not comply with this requirement. A closed system is defined as that which, although not necessarily air-tight, is not intended to be vented outside the enclosure.

Exception No. 2: Air filters located external to the enclosure and constructed of materials classed HB or less flammable need not comply with this requirement.

9 Mechanical Assembly

9.1 Loosening of parts in an appliance resulting from the vibration of handling and operation shall not result in a risk of fire, electric shock, or injury to persons.

9.2 Screws with properly applied lock washers, screws tightened by means of a power tool, and screws that are staked and upset are not considered subject to loosening.

9.3 A rotating part that when loosened, results in a risk of fire, electric shock, or injury to persons shall be assembled so that the direction of rotation tends to tighten the means that hold the rotating part in place.

Exception: A keyed part, a part locked in place with a pin, or a part that has been determined to be the equivalent may be used as a means of holding a rotating part in place.

9.4 A switch, a fuseholder, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or similar component that is handled by persons shall be mounted securely, shall not turn or shift, and shall comply with the requirements specified in [9.5](#), [9.6](#), and [14.2.3.6](#).

Exception: The requirement that a switch shall not turn or shift may be waived if the following conditions are met:

- a) The switch is of 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) The means of mounting the switch make it unlikely that operation of the switch will loosen it;*
- c) Spacings are not reduced below the minimum intended values if the switch rotates; and*
- d) Operation of the switch is by mechanical means rather than by direct contact by persons.*

9.5 The means for securing a component mentioned in [9.4](#) is to consist of more than friction between surfaces – for example, a properly applied lock washer or a keyed part that has been determined to be an acceptable means for securing a small stem-mounted switch or other device having a single-hole mounting means.

9.6 An uninsulated live part or a component that has uninsulated live parts shall be secured to the base or mounting surface so that it will be prevented from turning or shifting in position if such displacement may result in a reduction of spacings below the minimum intended values. See [9.4](#).

9.7 A lampholder, a fuseholder, and a circuit breaker shall be constructed and installed so that persons servicing the lamp, the fuse, or the circuit breaker may not unintentionally touch an uninsulated live part other than the screw shell of a lampholder or fuseholder, or the clip of a fuseholder.

Exception: An appliance that is marked in accordance with [54.22](#) need not comply.

9.8 An appliance may be shipped from the factory unassembled, or disassembled to the degree necessary to facilitate shipment, when the conditions described in (a) – (d) are met:

- a) All of the parts are furnished;
- b) The appliance is constructed so that field assembly can be accomplished without drilling, cutting, threading, or any other alteration other than the attachment of field-installed electrical conduit or raceway;
- c) The relationship between separate parts is established at the time of manufacture and is not dependent upon installation personnel; and
- d) The assembly of the appliance is restricted to an arrangement whereby electrical connections are accomplished by means of properly identified receptacles and plug-in connectors.

10 Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts

10.1 To reduce the risk 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).

- a) For an opening that has a minor dimension (see [10.5](#)) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in [Figure 10.1](#).
- 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 10.1](#).

Exception: A motor other than one used in either a hand-held product or a hand-supported portion of a product need not comply with these requirements when it complies with the requirements in [10.2](#).

Table 10.1
Minimum distance from an opening to a part that may involve a risk of electric shock or injury to persons

Minor dimension of opening, ^a		Minimum distance from opening to part,	
inches ^b	(mm) ^b	inches ^b	(mm) ^b
3/4 ^c	19.1	4-1/2	114.0
1 ^c	25.4	6-1/2	165.0
1-1/4	31.8	7-1/2	190.0
1-1/2	38.1	12-1/2	318.0
1-7/8	47.6	15-1/2	394.0
2-1/8	54.0	17-1/2	444.0
d	d	30	762.0

^a See [10.5](#).
^b Between 3/4 and 2-1/8 inches (19.1 and 54 mm), interpolation is to be used to determine a value between the values specified in the table.
^c Any dimension less than 1 inch (25.4 mm) applies to a motor only.
^d More than 2-1/8 inches, but not more than 6 inches (152.0 mm).

10.2 With respect to a part or wire as mentioned in [10.1](#), in an integral enclosure of a motor as specified in the Exception to [10.1](#):

a) An opening that has a minor dimension (see [10.5](#)) less than 3/4 inch (19.1 mm) may be used when:

- 1) A moving part cannot be contacted by the probe illustrated in [Figure 10.2](#);
- 2) Film-coated wire cannot be contacted by the probe illustrated in [Figure 10.3](#);
- 3) In a directly accessible motor (see [10.6](#)), an uninsulated live part cannot be contacted by the probe illustrated in [Figure 10.4](#); or
- 4) In an indirectly accessible motor (see [10.6](#)), an uninsulated live part cannot be contacted by the probe illustrated in [Figure 10.2](#).

b) An opening that has a minor dimension of 3/4 inch or more may be used if a part or wire is spaced from the opening as specified in [Table 10.1](#).

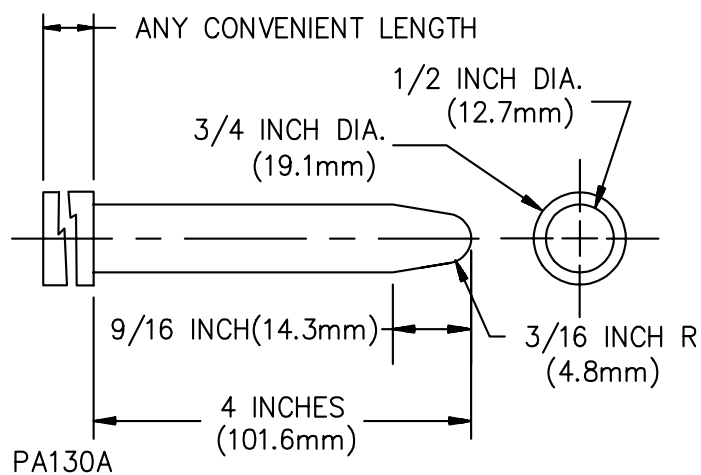
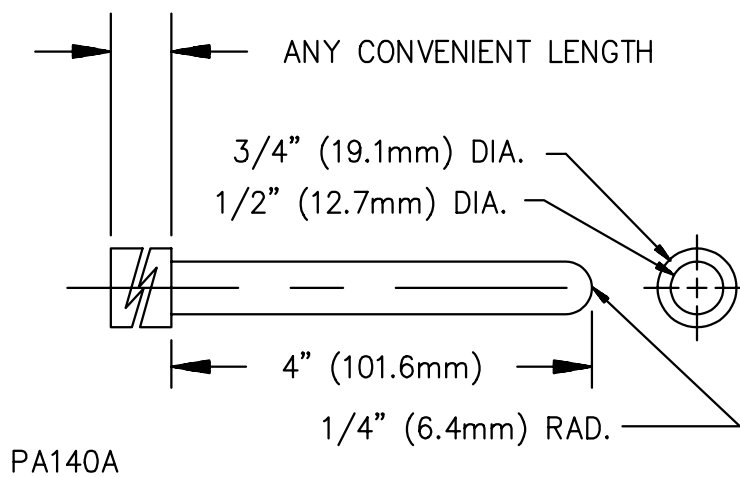
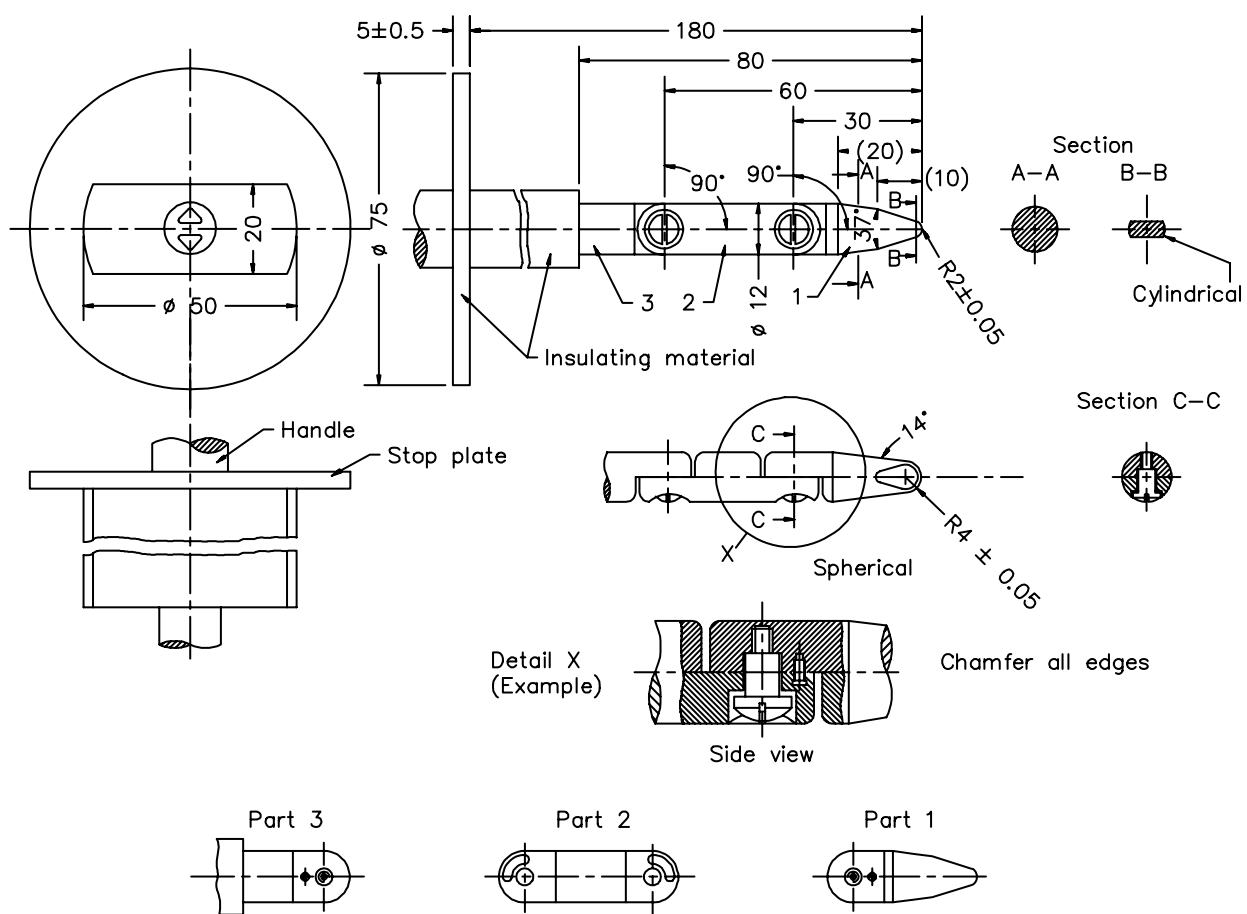
Figure 10.2**Probe for moving parts and uninsulated live parts****Figure 10.3****Probe for film-coated wire**

Figure 10.4
Articulate probe



SA1788A

10.3 The probes mentioned in [10.1](#) and [10.2](#) and illustrated in [Figure 10.1](#) – [Figure 10.4](#) shall be applied to any depth that the opening will permit; and shall 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 [Figure 10.1](#) and [Figure 10.4](#) shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

10.4 The probes mentioned in [10.3](#) and [10.5](#) shall 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 shall be applied with the minimum force necessary to determine accessibility.

10.5 With reference to the requirements in [10.1](#) and [10.2](#), 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.

10.6 With reference to the requirements in [10.2](#), an indirectly accessible motor is:

- a) Accessible only by opening or removing a part of the outer enclosure, such as a guard or panel, that can be opened or removed without using a tool or
- b) Located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted.

A directly accessible motor is that which can be contacted without opening or removing any part, or is that which is located so as to be accessible to contact.

10.7 During the examination of a product to determine whether it complies with the requirements in [10.1](#) or [10.2](#), a part of the enclosure that may be opened or removed by the user without using a tool (to attach an accessory, to make an operating adjustment, or for other reasons) or a part that is opened to collect coins is to be opened or removed.

10.8 With reference to the requirements in [10.1](#) and [10.2](#), insulated brush caps are not required to be additionally enclosed.

11 Protection Against Corrosion

11.1 Iron and steel parts shall be protected against corrosion by enameling, zinc coating, galvanizing, plating, or equivalent means if the corrosion of such unprotected parts is likely to result in a risk of fire, electric shock, or injury to persons.

Exception No. 1: Bearings, laminations, or minor parts made of iron or steel, such as washers, screws, and the like need not be so protected.

Exception No. 2: In certain instances where the oxidation of iron or steel due to the exposure of the metal to air and moisture is not likely to be appreciable – thickness of metal and temperature also being factors – surfaces of sheet steel and cast-iron parts within the enclosure may not be required to be protected against corrosion.

11.2 An electrical enclosure of sheet steel that may be exposed to the effects of weathering shall be protected against corrosion as specified in [11.3](#) – [11.9](#) or by other metallic or nonmetallic coatings that have been determined to provide equivalent protection.

Exception: A motor enclosure that is contained within the enclosure of the appliance need not comply.

11.3 An enclosure that is 0.053 inch (1.35 mm) thick or thicker and is contained within another enclosure shall be protected by one of the following coatings:

- 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) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M. See [11.9](#).
- b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness not less than 0.00041 inch (0.0104 mm) on each surface with a minimum thickness of 0.00034 inch (0.0086 mm). See [11.8](#).
- c) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. The acceptability of the paint is to be determined by consideration of its composition or by corrosion tests if such tests are considered necessary.

11.4 An enclosure that is less than 0.053 inch (1.35 mm) thick, or that is intended to provide the sole enclosure of current-carrying parts shall be protected by one of the following coatings:

- a) Hot-dipped, galvanized sheet steel conforming with the coating Designation G90 in Table I of the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M. See [11.9](#).
- b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness not less than 0.00061 inch (0.0155 mm) on each surface with a minimum thickness of 0.00054 inch (0.0137 mm). An annealed coating shall also comply with the requirements in [11.5](#). See [11.8](#).
- c) A cadmium coating not less than 0.001 inch (0.03 mm) thick on both surfaces. See [11.8](#).
- d) A zinc coating conforming with [11.3](#) (a) or (b) with one coat of outdoor paint – applied after forming – as specified in [11.3](#)(c).
- e) A cadmium coating not less than 0.00075 inch (0.0191 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.0005 inch (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The paint shall be as specified in [11.3](#)(c). See [11.8](#).

11.5 An annealed zinc coating that is bent or similarly formed after annealing shall additionally be painted in the bent or formed area if the bending or forming process damages the zinc coating.

11.6 When flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 times power magnification, the zinc coating is considered damaged. Simple sheared or cut edges and punched holes are not considered to be formed, but extruded and rolled edges and holes are to comply with [11.5](#).

11.7 With reference to the requirement in [11.2](#), other finishes, including paints, metallic finishes, and combinations of the two may be used if comparative tests with galvanized sheet steel, without annealing, wiping, or other surface treatment, complying with [11.3](#)(a) or [11.4](#), as applicable, indicate they provide equivalent protection. Among the factors that are taken into consideration when judging the acceptability of such coating systems are exposure to salt spray, moist carbon dioxide-sulfur dioxide-air mixtures, moist hydrogen sulfide-air mixtures, ultraviolet light, and water.

11.8 The thickness of the metallic coating specified in [11.3](#)(b), and [11.4](#) (b), (c), and (e) shall be established by the Metallic Coating Thickness Test, Section [48](#).