



UL 1647

Underwriters Laboratories Inc. Standard for Safety

Motor-Operated Massage and Exercise Machines



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UL Standard for Safety for Motor-Operated Massage and Exercise Machines, UL 1647

Fourth Edition, Dated January 23, 2008

SUMMARY OF TOPICS

The revisions dated August 5, 2009 were issued to correct the effective date notes as follows:

- *The effective date for Paragraph 7.2.1 is now the future effective date of August 5, 2011*
- *The effective date for Paragraphs 6.6, 11.6, 19.2, 19.3, 32.3.1 and 32.3.2 is now June 11, 2009*

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The following table lists the future effective dates with the corresponding reference.

Future Effective Date	References
August 5, 2011	Clauses 1.2.1, 1.3.1, 1.4, 5.3.1, 5.9, 9A, 7.2.1, 12.1.1.10, 33.4.1, 34A, 34B, 40.2.5, 44A, 45.1 – 45.4, 45A, 45B, 51.3, 52.2, 52.3, 54.6.3, 58A, 58B, 62.5 – 62.7, 64.6, 65.4

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This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through August 5, 2009.

The most recent designation of ANSI/UL 1647 as an American National Standard (ANSI) occurred on June 11, 2009. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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INTRODUCTION

1 Scope

1.1 These requirements cover motor-operated massage and exercise machines, such as vibrators, exercise bicycles, vibrating and massaging chairs, and the like, are to be employed in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements also cover massage and exercise machines such as vibrators in which motion of an operating part is produced by electrical means.

1.2.1 These requirements also cover portable motor-operated massage type footbaths that may employ a heating function. The massage function is produced mechanically by a motor or vibrating coil, or by a motor that pumps air (bubble massage) or circulates water (hydro-massage).

Added 1.2.1 effective August 5, 2011

1.3 These requirements do not cover appliances rated more than 250 V.

1.3.1 These requirements do not cover footbaths without a motor-operated massage type function.

Added 1.3.1 effective August 5, 2011

1.4 These requirements also cover motorized and non-motorized inversion tables.

Added 1.4 effective August 5, 2011

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.

3 Units of Measurement

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

4 Undated References

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

5 Glossary

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

5.2 AUTOMATICALLY CONTROLLED APPLIANCE – An appliance is considered to be automatically controlled if:

- a) The repeated starting of the appliance, beyond one complete predetermined cycle of operation to the point where some form of limit switch opens the circuit, is independent of any manual control,
- b) During any single predetermined cycle of operation, the motor is caused to stop and restart one or more times,
- c) Upon energizing the appliance, the initial starting of the motor may be intentionally delayed beyond normal, conventional starting, or
- d) During any single predetermined cycle of operation, automatic changing of the mechanical load may reduce the motor speed sufficiently to reestablish starting-winding connections to the supply circuit.

5.3 FIXED APPLIANCE – An appliance that is intended to be permanently connected electrically to the wiring system.

5.3.1 INVERSION TABLE – An appliance that is intended to invert the user by rotating a table through various inversion angles while the user's ankles are secured in a clamping device. When the table is in its full inverted position, the user is supported entirely by an ankle-clamping device. Motion of the table is either motorized (motor-operated) or non-motorized (body-weight operated).

Added 5.3.1 effective August 5, 2011

5.4 LINE-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 250 V and having circuit characteristics in excess of those of a low-voltage circuit.

5.5 LOW-VOLTAGE CIRCUIT – A circuit involving a peak open-circuit potential of not more than 42.4 V supplied by a primary battery, by a Class 2 transformer, or by a combination of a transformer and a fixed impedance that, as a unit, complies with all performance requirements for a Class 2 transformer. A circuit derived from a line-voltage circuit by connecting a resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low-voltage circuit.

5.6 PORTABLE APPLIANCE – A cord connected appliance that is hand-held when used or easily conveyed by hand and weighs 40 lb (18.15 kg) or less.

5.7 REMOTELY CONTROLLED APPLIANCE – An appliance that is out of sight of the operator who is at the starting device.

5.8 STATIONARY APPLIANCE – A cord connected appliance weighing more than 40 lb (18.15 kg).

5.9 TREADMILL BELT – The moving surface of the treadmill, on which the user walks, jogs, or runs.

Added 5.9 effective August 5, 2011

CONSTRUCTION

6 General

6.1 An appliance shall employ materials that are acceptable for the application.

6.2 An appliance employing a heating element is judged on the basis of its compliance with the requirements in this standard insofar as they apply, and with the applicable requirements in the Standard for Electric Heating Appliances, UL 499.

6.3 Foam padding provided with an appliance having a heating pad shall comply with the requirements for HBF or better material.

6.4 Thermoplastic material used for a part of an appliance having any dimension (length, width, or height) greater than 12 in (305 mm) shall be classified HB.

6.5 A heating pad employed in a massage or exercise machine shall comply with the applicable requirements in the Standard for Electric Heating Pads, UL 130.

Exception: A heating pad that is not accessible and that complies with the requirements in the Resistance to Moisture Test, Section 44; Flexing and Twisting Test, Section 50; and Thermostat Test, Section 47, is acceptable.

6.6 Fabric, batting, padding, foam, and synthetic or natural leather shall not be relied upon to serve as an electrical enclosure (or barrier) for insulated live parts, including internal wiring, and uninsulated live parts. Nor shall it be used to support a live part, be in direct contact with a live part, or be within 1/32 inch (0.8 mm) of a live part.

6.6 added June 11, 2009

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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 is likely to be subjected, without resulting in a 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 For unreinforced, flat surfaces in general, cast metal shall not be less than 1/8 in (3.2 mm) thick, except that malleable iron may be not less than 3/32 in (2.4 mm) and die-cast metal may be not less than 5/64 in (2.0 mm) thick. Corresponding thicknesses of not less than 3/32, 1/16 (1.6 mm), and 3/64 in (1.2 mm), respectively, may be acceptable if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape or size, or both, of the surface is such that the necessary mechanical strength is provided.

7.1.3 An enclosure of sheet metal shall be judged with respect to its size, shape, thickness of metal, and its application, considering the intended use of the complete appliance. Sheet steel having a thickness of less than 0.026 in (0.66 mm) if uncoated or 0.029 in (0.74 mm) if galvanized or of nonferrous sheet metal having a thickness of less than 0.036 in (0.91 mm) shall not be used, except for relatively small areas or for surfaces that are curved or otherwise reinforced.

7.1.4 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than 0.032 in (0.81 mm) if uncoated steel, not less than 0.034 in (0.86 mm) if galvanized steel, and not less than 0.045 in (1.14 mm) if nonferrous.

7.1.5 Among the factors that shall be evaluated when determining the acceptability of magnesium or a nonmetallic material, other than a polymeric material, are resistance to:

- a) Mechanical damage,
- b) Impact,
- c) Moisture absorption,
- d) Combustion, and
- e) Distortion at temperatures to which the material is subjected under conditions of normal or abnormal use.

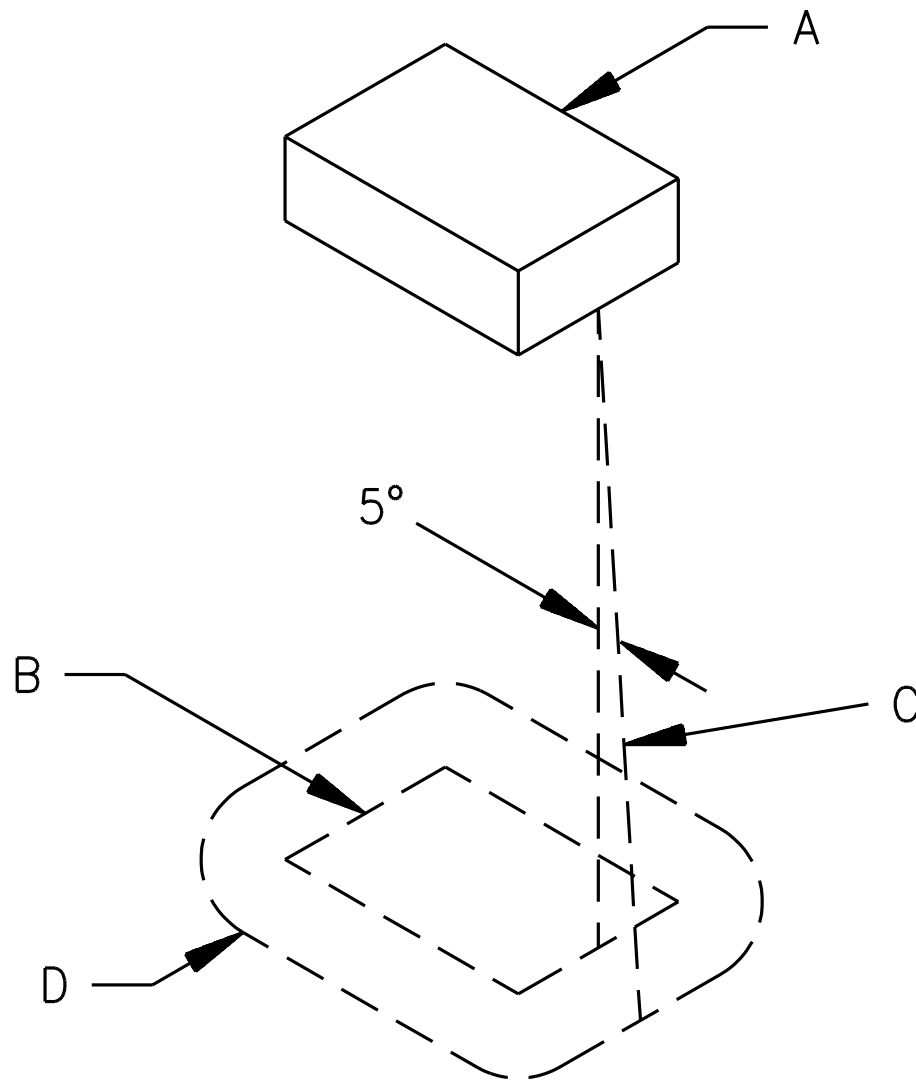
7.1.6 The enclosure of a remotely or automatically controlled appliance shall prevent molten metal, burning insulation, flaming particles, or the like, from falling on combustible materials, including the surface upon which the appliance is supported.

7.1.7 The requirement in 7.1.6 will necessitate that a switch, a relay, a solenoid, or the like, be individually and completely enclosed, except for terminals, unless it can be shown that malfunction of the component would not result in a risk of fire, or there are no openings in the bottom of the appliance enclosure. It will also necessitate the use of a barrier of noncombustible material:

- a) Under a motor unless:
 - 1) The structural parts of the motor or of the appliance provide the equivalent of such a barrier,
 - 2) The 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 starting winding,
 - iii) Starting switch short-circuited, and
 - iv) Capacitor of permanent-split capacitor motor short circuited – the short-circuit is to be applied before the motor is energized, and the rotor is to be locked,
 - 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 125°C (257°F) under the maximum load under which the motor will run without causing the protector to cycle and from exceeding 150°C (302°F) with the rotor of the motor locked, or
 - 4) The motor complies with the requirements in the Standard for Overheating Protection for Motors, UL 2111, and the temperature of the motor winding will not exceed 150°C during the first 72 hours of operation with the rotor of the motor locked.
- b) Under wiring, unless it is neoprene- or thermoplastic-insulated.

7.1.8 The barrier mentioned in 7.1.7 shall be horizontal, shall be located as illustrated in Figure 7.1, and shall not have an area less than that described in that illustration. Openings for drainage, ventilation, and the like, may be employed in the barrier, provided such openings would not permit molten metal, burning insulation, or the like, to fall on combustible material.

Figure 7.1
Location and extent of barrier



EB120A

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 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.

7.1.9 A door or a cover of an enclosure that provides access to any overload-protective device that requires resetting or renewal shall be hinged or otherwise attached in an equivalent manner.

7.1.10 Means shall be provided for holding the door or cover over a fuseholder in a closed position, and the door or cover shall be tight-fitting.

7.1.11 A cord-connected appliance that is provided with keyhole slots, notches, hanger holes, or the like, for hanging on a wall shall be constructed in such a manner that the hanging means is not accessible without removing the appliance from the supporting means.

7.1.12 To determine whether a product complies with the requirement in 7.1.11, any part of the enclosure or barrier that can be removed without the use of tools to gain access to the hanging means is to be removed.

7.1.13 An opening in the appliance provided for hanging shall be located or guarded so that a nail, hook, or the like does not displace a part that would create a risk of fire or electric shock and does not contact one of the following:

- a) An uninsulated live metal part.
- b) Magnet wire.
- c) Internal wiring.
- d) Moving parts.
- e) Any other part likely to create a risk of fire or electric shock.

7.2 Polymeric material enclosure

7.2.1 A polymeric material used to enclose uninsulated live parts, or enclose live parts having insulation less than 0.028 in (0.71 mm) thick or equivalent, shall comply with the Polymeric Enclosure Tests, Section 54, and shall have a flammability class determined in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, as follows:

- a) Class 5VA for a fixed or stationary appliance or for an appliance that is permanently installed,

Exception No. 1: A polymeric material classed HB minimum is capable of being used for a stationary appliance intended for household use, and that is cord connected, attended, and intermittent duty when it complies with all the following:

- 1) All motors shall be provided with motor-overload protection complying with 21.2.2,*
- 2) Transformers shall comply with the Standard for Class 2 and Class 3 Transformers, UL 1585 or the Standard for Low Voltage Transformers: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers: Class 2 and Class 3 Transformers, UL 5085-3; Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411; or Class 2 Power Units, UL 1310; and*
- 3) The appliance shall be provided with wheels or casters to facilitate movement from one location to another.*

Exception No. 2: A polymeric material classed V-2 minimum is capable of being used for a stationary appliance intended for commercial use and that is cord connected, attended, and intermittent duty when it complies with all of the following:

- 1) All motors shall be provided with motor-overload protection complying with 21.2.2,*
- 2) Transformers shall comply with the Standard for Class 2 and Class 3 Transformers, UL 1585 or the Standard for Low Voltage Transformers: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers: Class 2 and Class 3 Transformers, UL 5085-3; Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411; or Class 2 Power Units, UL 1310, and*
- 3) The appliance shall be provided with wheels or casters to facilitate movement from one location to another.*

b) Class HB minimum for a portable, attended, intermittent duty, household appliance, or

Exception: Class V-2 minimum for a polymeric material used to enclose heating elements, including heating wire.

c) Class V-2 minimum for an appliance other than mentioned in (a) and (b).

Revised 7.2.1 effective August 5, 2011

7.2.2 A polymeric material used to enclose insulated live parts having insulation 0.028 in (0.71 mm) thick minimum or equivalent, internal wiring, or moving parts shall have a flammability class of HB minimum, and shall comply with Mold Stress-Relief Distortion, Section 54.1, and Impact, Section 54.2.

7.2.3 The volume resistivity of a polymeric material used in an enclosure as specified in 7.2.1, determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, shall not be less than:

- a) 50 MΩ-cm after conditioning for 40 h at 23 ±2°C (73 ±4°F) and 50 ±5 percent relative humidity, and
- b) 10 MΩ-cm after exposure for 96 hours to moist air having a relative humidity of 90 ±5 percent at a temperature of 35 ±2°C (95 ±4°F).

Exception: A polymeric material having a volume resistivity lower than specified in (a) and (b) is capable of being used when the enclosure is determined to be a noncurrent-carrying metal part, and the product complies with Spacings, Section 26, and Spacings to Polymeric Enclosures, Section 26.2.

7.2.4 For a portable appliance, a polymeric material used to enclose uninsulated or insulated live parts shall have a hot wire ignition (HWI) performance level category (PLC) not greater than 4 – see Table 14.1 – as a result of the HWI test described in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

Exception: The material is not required to have a hot wire ignition rating when the live parts, including all internal wiring, are spaced 1/2 in (12.7 mm) or more from the material.

7.2.5 For a stationary or fixed appliance, a polymeric material used to enclose uninsulated or insulated live parts shall have a hot wire ignition (HWI) performance level category (PLC) not greater than 3 – see Table 14.1 – as a result of the HWI test, described in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

Exception: The material is not required to have a hot wire ignition rating when the live parts, including all internal wiring, are spaced 1/2 in (12.7 mm) or more from the material.

8 Adhesives Used to Secure Parts

8.1 An adhesive that is relied upon to reduce a risk of electric shock, fire, or injury to persons shall comply with the requirements for adhesives in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

8.2 The requirement in 8.1 also applies to an adhesive used to secure a conductive part, including a nameplate, that may, if loosened or dislodged:

- a) Energize an accessible dead metal part,
- b) Make a live part accessible,
- c) Reduce spacings below the minimum acceptable values, or
- d) Short-circuit live parts.

9 Mechanical Assembly

9.1 An appliance shall be assembled so that it will not be adversely affected by the vibration of intended operation. Brush caps shall be tightly threaded or otherwise constructed to prevent loosening.

9.2 A switch other than a through-cord switch, a lampholder, a plug adapter, a motor-attachment plug, or similar component shall be mounted securely and shall be prevented from turning. See 9.4.

Exception No. 1: A switch need not be prevented from turning if all four of the following conditions are met:

- a) The switch is of a plunger 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 intended operation of the switch.*
- b) The means for mounting the switch makes it unlikely that operation of the switch will loosen it.*
- c) The spacings are not reduced below the minimum required values if the switch rotates.*
- d) The intended operation of the switch is by mechanical means rather than by direct contact by persons.*

Exception No. 2: A lampholder of the type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in a nonremovable jewel, need not be prevented from turning if rotation cannot reduce spacings below the minimum required values.

9.3 Uninsulated live parts shall be secured to the base or mounting surface so that they will be prevented from turning or shifting in position, if such motion may result in a reduction of spacings below the minimum acceptable values.

9.4 The means for preventing the turning or shifting mentioned in 9.2 and 9.3 is to consist of more than friction between surfaces – for example, a properly applied lock washer, is acceptable as the means for preventing a small stem-mounted switch or other device having a single-hole mounting means, from turning.

9A Mechanical Securement of Fluid-Handling Tubing

Added Section 9A effective August 5, 2011

9A.1 For a massage type footbath, fluid-handling tubing shall be mechanically secured at connections if there is a risk of fire or electric shock should the tubing become disconnected. This mechanical securement shall not rely upon friction between surfaces alone. See the Fluid-Handling Tubing Tests, Section 45A.

10 Protection Against Corrosion

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

Exception No. 1: Surfaces of sheet-steel and cast-iron parts within an enclosure may not be required to be protected against corrosion if the oxidation of the metal due to the exposure to air and moisture is not likely to be appreciable. The thickness of metal and temperature are also to be considered.

Exception No. 2: This requirement does not apply to bearings, laminations, or minor parts of iron or steel, such as washers, screws, and the like.

10.2 If deterioration of a liquid container provided as a part of an appliance would result in a risk of fire or electric shock, the container shall be of a material that is resistant to corrosion by the liquid intended to be used therein.

11 Accessibility of Uninsulated Live Parts and Film-Coated Wire

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, an opening in an enclosure shall comply with either (a) or (b):

a) For an opening that has a minor dimension (see 9.3) less than 1 in (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 11.1.

b) For an opening that has a minor dimension of 1 in or more, such a part or wire shall be spaced from the opening as specified in 11.5 and Figure 11.2.

11.2 The probe mentioned in 11.1 and illustrated in Figure 11.1 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 probe shall be applied in any possible configuration, and, if necessary, the configuration shall be changed after insertion through the opening.

11.3 With reference to the requirements in 11.1, 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.

11.4 During the examination of an appliance to determine whether it complies with the requirements in 11.1, 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) is to be opened or removed.

11.5 An opening as specified in 11.1(b) and illustrated in Figure 11.2 is acceptable if, within the enclosure, there is no uninsulated live part or film-coated wire:

- a) Less than X distance from the perimeter of the opening, as well as,
- b) Within the volume generated by five times the diameter of the largest round rod that can be inserted through the opening, but not less than 4 in (102 mm).

In evaluating an opening, any barrier located within the volume usually is ignored unless it intersects the boundaries of the volume in a continuous, closed line.

11.6 During the examination of an appliance to determine whether it complies with the requirements in 11.1, the materials mentioned in 6.6 shall be removed.

11.6 added June 11, 2009

Figure 11.1
Articulate probe with web stop

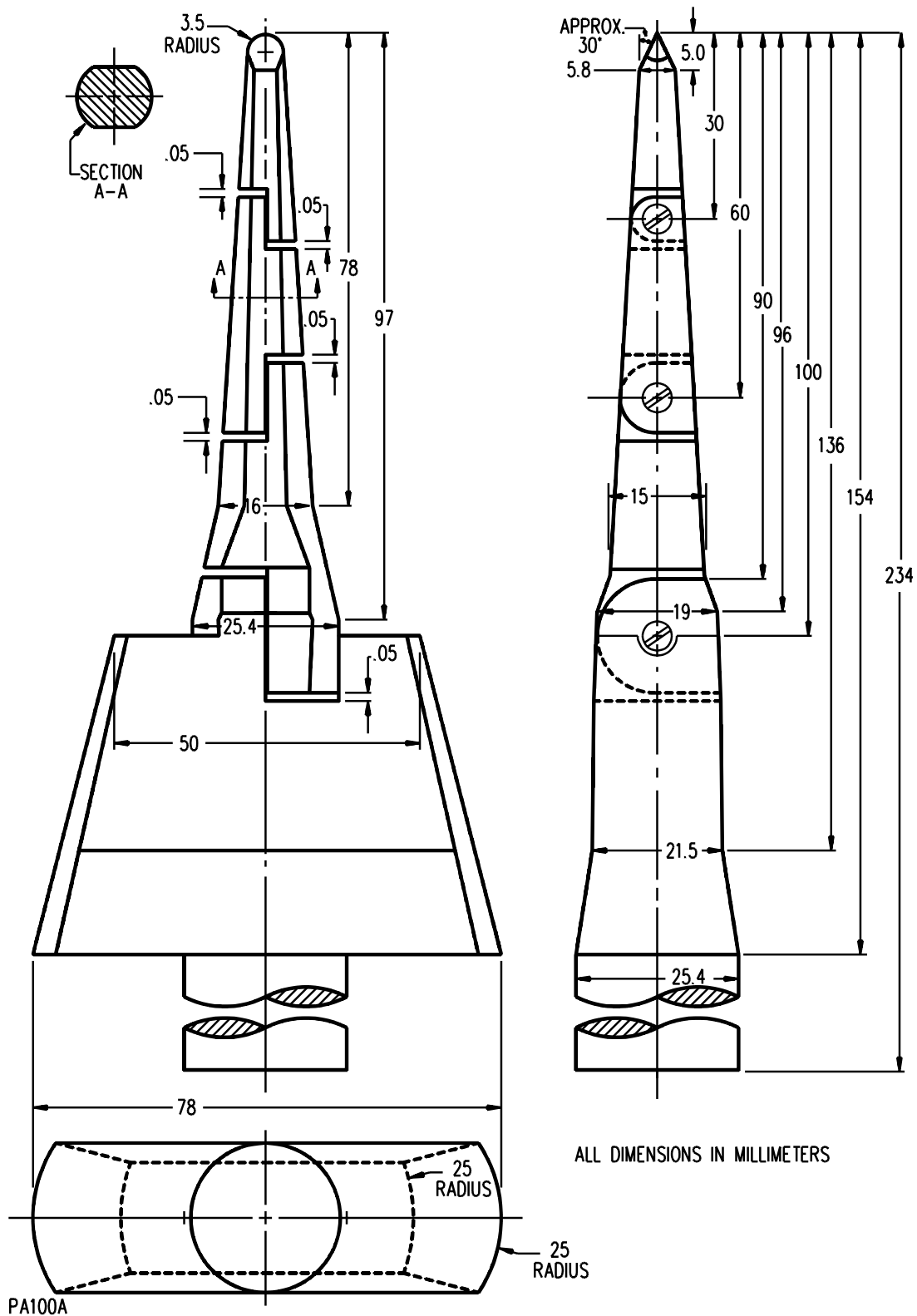
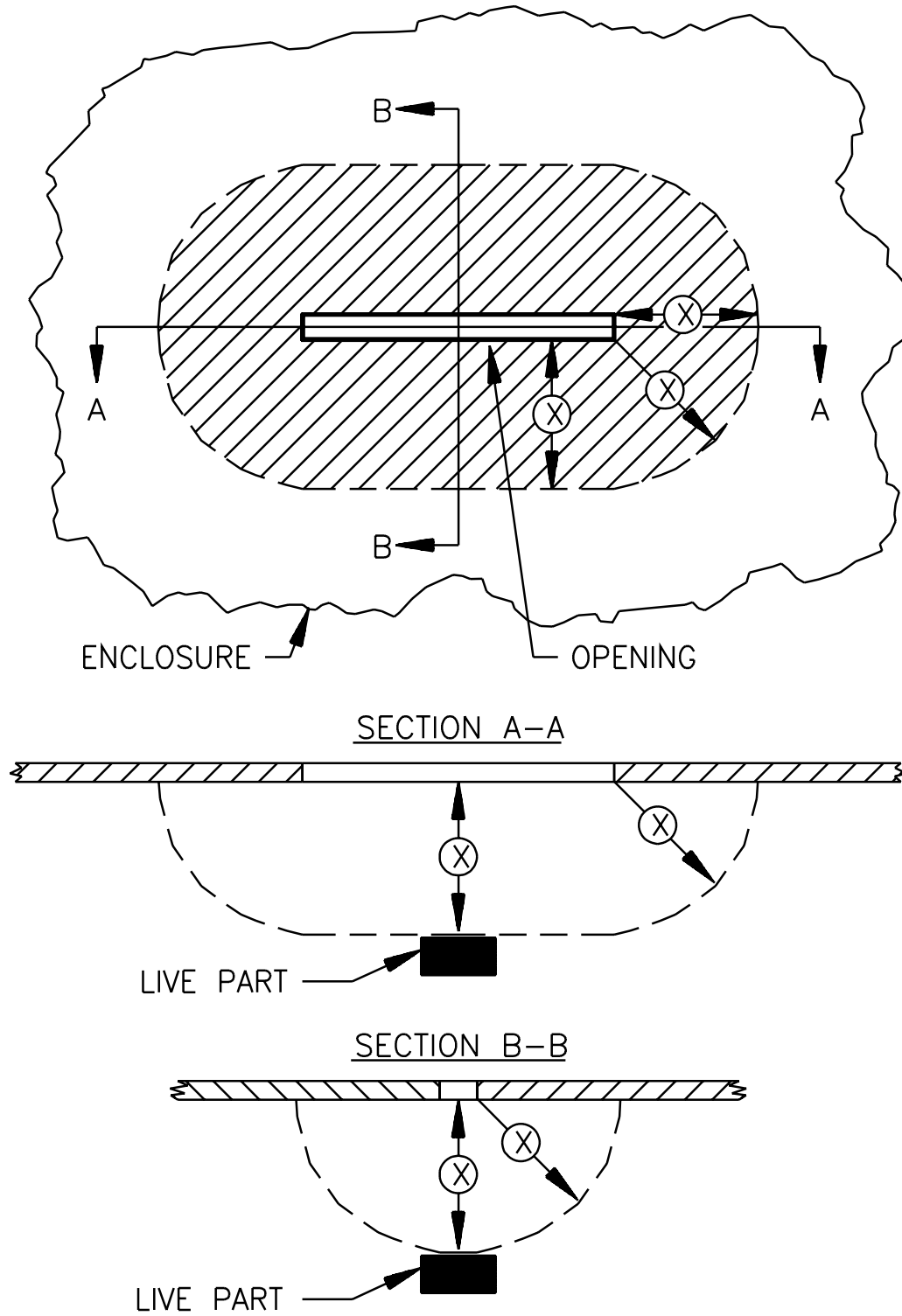


Figure 11.2
Opening in enclosure



EC100A

12 Supply Connections

12.1 Cord-connected appliances

12.1.1 Cords and plugs

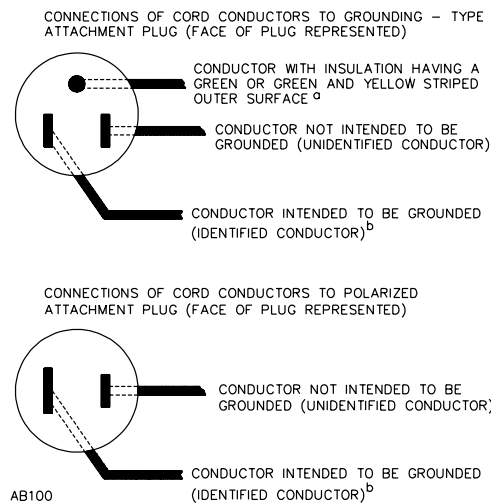
12.1.1.1 An appliance intended to be connected to the power-supply circuit by means of a flexible cord shall be provided with a flexible cord and an attachment plug for connection to the supply circuit.

12.1.1.2 The attachment plug of an appliance intended to be connected to a nominal 120 V circuit, and employing devices required to be connected to a specific supply conductor as specified in 20.1, 23.2, and 24.6 shall be a polarized type. The connections to the attachment plug shall be in accordance with Figure 12.1. The polarity identification of the supply cord shall be in accordance with Table 12.1. See 65.3.

Table 12.1
Polarity identification of flexible cords

Method of identification	Acceptable combinations	
	Conductors intended to be grounded ^{a,b}	All other conductors ^a
Color of braid on individual conductors	Solid white or gray – without tracer	Solid color other than white or gray – without tracer
	Color other than white or gray, with tracer in braid	Solid color other than white or gray – without tracer
Color of insulation on individual conductors	Solid white or gray ^c	Solid color other than white or gray
	Solid light blue ^d	Solid color other than light blue, white, or gray
Color of separators	Solid white or gray ^d	Solid color other than white or gray
Other means	Tin or other white metallic coating on all strands of the conductor ^e	No tin or other white metallic coating on the strands of the conductor
	A stripe, ridge or groove on the exterior surface of the cord ^f	
^a An insulating conductor finished to show a green color with or without one or more yellow stripes or tracers is to be used only as an equipment-grounding conductor. See 18.2.1 and Figure 12.1. ^b The grounded (identified) conductor is the neutral supply conductor. ^c Only for cords – other than Types SP-1, SP-2, SPE-1, SPE-2, SPT-1, and SPT-2, – having no braid on any individual conductor. ^d For jacketed cords. ^e Only for Types SPT-1 and SPT-2 cords. ^f Only for Types SP-1, SP-2, SPE-1, SPE-2, SPT-1, and SPT-2 cords.		

Figure 12.1
Connections to attachment plugs



^a In the above illustration, the blade to which the green conductor is connected may have a U-shape instead of a circular cross section.

^b Signifies a conductor identified in accordance with Table 12.1. The grounded (identified) conductor is the neutral supply conductor.

12.1.1.3 An appliance that is required to employ a polarized attachment plug as specified in 12.1.1.2, and that is provided with a separate or detachable cord set as specified in the exception to 12.1.1.6 and 12.1.1.8 shall also employ an appliance connector of the polarized type.

12.1.1.4 The ampacity of the cord and the current rating of the attachment plug shall not be less than the maximum normal load current of the appliance. The voltage rating of the cord shall not be less than that of the appliance. The voltage rating of the attachment plug shall be equal to that of the appliance.

12.1.1.5 The flexible cord shall be as specified in Table 12.2, or shall be of a type at least equally serviceable for the application.

12.1.1.6 The flexible cord shall not be less than 6 ft (1.83 m) long and shall be attached to the appliance.

Exception: An appliance that is not required to be provided with a grounding conductor may be provided with a separate cord-set having means for connection to the appliance and a length of not less than 6 ft.

Table 12.2
Cords for appliances

Appliance type	Cord type
Household use other than noted below	SP-2, SPE-2, or SPT-2
Commercial use other than noted below	SJ, SJE, or SJT
Hand held weighing 1 lb (454 g) or less	TP, TPT
Hand held, household use, weighing more than 1 lb (454 g)	SP-1, SPE-1, or SPT-1
Hand held, commercial use, weighing more than 1 lb (454 g)	SP-2, SPE-2, or SPT-2
Chair, tables, and the like	SJ, SJE, or SJT
Commercial use, footstool or cushion type	SV, SVE, SVO, SVOO, SVT, SVTO, or SVTOO

12.1.1.7 The length of an attached flexible cord includes the attachment plug. The length of a cord-set includes the fittings.

12.1.1.8 A household appliance intended for use with a detachable cord-set shall not be provided with terminal pins that will accommodate a standard flatiron or appliance plug.

12.1.1.9 If an appliance can be adapted for use on two or more different values of voltage by field alteration of internal connections, the attachment plug provided with the appliance shall be acceptable for the voltage for which the appliance is connected when shipped from the factory. See 62.1.3.

12.1.1.10 A massage type footbath shall employ a flexible cord that is attached to the appliance.

Added 12.1.1.10 effective August 5, 2011

12.1.2 Strain relief

12.1.2.1 Strain relief shall be provided so that mechanical stress on a flexible cord will not be transmitted to terminals, splices, or interior wiring.

12.1.2.2 A metal strain-relief clamp or band used with Type SP-2, SPE-2 or lighter general-use rubber-insulated cord shall be provided with auxiliary insulation over the cord for mechanical protection.

Exception: The auxiliary insulation may be omitted for Type SV, SVE, SVO, or SVOO cord.

12.1.2.3 A clamp of any material – metal or otherwise – shall not be used on Type SPT-1, SVT, SVTO, SVTOO, SPT-2, TP, or TPT cord or on cords of similar or lighter construction.

Exception No. 1: A clamp is capable of being used on Type SPT-1, SVT, SVTO, SVTOO, SPT-2, TP, or TPT (or similar) cord protected by varnished cloth tubing, phenolic, vulcanized rubber, or the equivalent under the cord grip, when the construction complies with Strain-Relief Clamp Test, Section 49. Thermoplastic tubing shall not be used over thermoplastic cords.

Exception No. 2: This requirement does not apply to a clamp that is rated for strain relief for the cord type used in the application.

12.1.2.4 For types of thermoplastic-insulated cord, heavier than Type SPT-1, SPT-2, SVT, SVTO, or SVTOO, a clamp may be employed and the auxiliary insulation is not required unless it is judged that the clamp may damage the cord insulation.

12.1.2.5 Means shall be provided to prevent a flexible cord from being pushed into an appliance through a cord-entry hole if such displacement may subject the cord to mechanical damage or to exposure to a temperature higher than that for which the cord is acceptable, or may reduce a spacing, such as to a metal strain-relief clamp, below the minimum acceptable value.

12.1.2.6 If a knot in a flexible cord serves as strain relief, a surface that the knot may contact shall be free from projections, sharp edges, burrs, fins, and the like, that may cause abrasion of the insulation on the conductors.

12.1.3 Bushings

12.1.3.1 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent that shall be reliably secured in place, and shall have a smooth, rounded surface against which the cord may bear.

12.1.3.2 An insulating bushing shall be provided if:

- a) Type SP-1, SPE-1, SPT-1, SP-2, SPE-2, SPT-2, or other cord lighter than Type SV or SVE is employed,
- b) The wall or barrier is of metal, or
- c) The construction is such that the cord may be subjected to strain or motion.

Exception: An insulated metal grommet having insulating material that is not less than 1/32 in (0.8 mm) thick and fills completely the space between the grommet and the metal in which it is mounted may be used instead of an insulating bushing.

12.1.3.3 A cord hole in wood, porcelain, phenolic composition, or other nonconducting material and having a smooth, rounded surface is considered to be equivalent to a bushing.

12.1.3.4 Ceramic materials and some molded compositions are acceptable for insulating bushings.

12.1.3.5 A separate bushing shall not be made of wood or of hot-molded shellac-and-tar compositions.

12.1.3.6 A vulcanized fiber bushing shall not be less than 3/16 in (4.8 mm) thick and shall be formed and secured in place so that it will not be adversely affected by conditions of ordinary moisture.

12.1.3.7 A separate soft-rubber, neoprene, or polyvinyl chloride bushing shall not be employed in the appliance.

Exception No. 1: A separate soft-rubber, neoprene, or polyvinyl chloride bushing may be employed in the frame of a motor or in the enclosure of a capacitor attached to a motor provided that:

- a) The bushing is not less than 3/64 in (1.2 mm) thick, and*
- b) The bushing is located so that it will not be exposed to oil, grease, oily vapor, or other substances having a deleterious effect on the compound employed.*

Exception No. 2: A bushing of any of the materials mentioned in 12.1.3.7 may be employed at any point in an appliance if used in conjunction with a type of cord for which an insulating bushing is not required. If a bushing of one of these materials is used anywhere in the appliance, the edges of the hole in which the bushing is mounted are to be smooth and free from burrs, fins, and the like.

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12.1.3.8 At any point in an appliance, a bushing of the same material as, and molded integrally with, the supply cord is acceptable on a Type SP-1 or heavier cord if the built-up section is not less than 1/16 in (1.6 mm) thick at the point where the cord passes through the enclosure.

12.2 Permanently connected appliances

12.2.1 General

12.2.1.1 Except as noted in 12.2.1.2, an appliance intended for permanent connection to the power supply shall have provision for connection of one of the wiring systems that would be acceptable for the appliance.

12.2.1.2 A stationary appliance may be acceptable if provided with not more than 8 ft (2.44 m) of Type S, SE, SO, SOO, ST, STO, or STOO cord and an attachment plug for supply connection. The investigation of such a feature will include consideration of the utility of the appliance and the necessity of having it readily detachable from its source of supply by means of a plug.

12.2.2 Terminal compartment

12.2.2.1 A terminal box or compartment in which power-supply connections to a permanently connected appliance are to be made shall be located so that the connections may be readily inspected after the appliance is installed as intended.

12.2.2.2 A terminal compartment intended for connection of a supply raceway shall be attached to the appliance so as to be prevented from turning.

12.2.2.3 The terminal compartment on a motor that is intended to be connected directly to the supply shall comply with the requirements for terminal compartments in the Standard for Electric Motors, UL 1004.

12.2.3 Wiring terminals and leads

12.2.3.1 A permanently connected appliance shall be provided with wiring terminals for the connection of conductors having an ampacity acceptable for the appliance, or the appliance shall be provided with leads for such connection.

12.2.3.2 A field-wiring terminal is considered to be a terminal to which a wire may be connected in the field, unless the wire and a means of making the connection – a pressure terminal connector, soldering lug, soldered loop, crimped eyelet, and the like – factory-assembled to the wire, are provided as a part of the appliance.

12.2.3.3 Wiring terminals for the supply conductors– excluding the grounding conductor – shall be provided with a pressure wire connector securely fastened in place, for example, firmly bolted or held by a screw.

Exception No. 1: A soldering lug may be used.

Exception No. 2: A wire binding screw may be employed at a wiring terminal intended to accommodate a 10 AWG (5.3 mm²) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in place.

12.2.3.4 A wiring terminal shall be prevented from turning.

12.2.3.5 The free length of a lead inside an outlet box or wiring compartment shall be 6 in (152 mm) or more if the lead is intended for field connection to an external circuit.

Exception: The lead may be less than 6 in long if it is evident that the use of a longer lead may result in a risk of fire or electric shock.

12.2.3.6 A wire-binding screw at a wiring terminal shall not be smaller than No. 10.

Exception No. 1: A No. 8 screw may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm²) conductor.

Exception No. 2: A No. 6 screw may be used for the connection of a 16 or 18 AWG (1.3 or 0.8 mm²) conductor. See 12.2.3.7.

12.2.3.7 According to the National Electrical Code, ANSI/NFPA 70, 14 AWG (2.1 mm²) is the smallest conductor that may be used for branch-circuit wiring, and therefore is the smallest conductor that may be anticipated at a terminal for connection of a power-supply wire.

12.2.3.8 A wire-binding screw shall thread into metal.

12.2.3.9 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050 in (1.27 mm) thick and shall not have less than two full threads in the metal.

Exception: An alloy plate may be not less than 0.030 in (0.76 mm) thick if the tapped threads have the necessary mechanical strength.

12.2.3.10 A terminal plate formed from stock having the thickness specified in 12.2.3.9 may have the metal extruded at the tapped hole to provide two full threads for the binding screw.

12.2.3.11 Upturned lugs or a cupped washer shall be capable of retaining a supply conductor of the size specified in 12.2.3.1 under the head of the screw or washer.

12.2.4 Identified terminals and leads

12.2.4.1 A permanently connected appliance rated 125 or 125/250 V (3-wire) or less and employing a lampholder of the Edison-screw-shell type, or a single-pole switch or overcurrent-protective device other than an automatic control without a marked off position, shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit.

12.2.4.2 A terminal intended for the connection of a grounded supply conductor shall be of or plated with metal that is substantially white in color and shall be readily distinguishable from the other terminals, or proper identification of that terminal shall be clearly shown in some other manner, such as on an attached wiring diagram.

12.2.4.3 A lead intended for the connection of a grounded power-supply conductor shall be finished white or gray color and shall be readily distinguishable from the other leads.

13 Current-Carrying Parts

13.1 A current-carrying part shall be of silver, copper, a copper alloy, stainless steel, or other similar metal.

13.2 Ordinary iron or steel shall not be used as a current-carrying part.

Exception: Ordinary iron or steel provided with a corrosion-resistant coating, may be used for a current-carrying part if acceptable in accordance with 2.1 – 2.3, or within a motor or associated governor.

14 Insulating Material

14.1 Material for mounting an uninsulated live part shall be porcelain, phenolic composition, or other equivalent material.

14.2 Ordinary vulcanized fiber may be used for insulating bushings, washers, separators, and barriers, but not as the sole support for uninsulated live parts where shrinkage, current leakage, or warpage may introduce a risk of fire or electric shock.

14.3 A polymeric material used to support a live part, in direct contact with a live part, or within 1/32 in (0.8 mm) of a live part shall be rated for use at the operating temperature involved and shall have the following material properties, determined in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A:

- a) Volume resistivity not less than 50 MΩ-cm,
- b) Comparative tracking index (CTI) performance level category (PLC) not greater than 4, and
- c) A PLC for high-current arc ignition (HAI) and hot wire ignition (HWI) not greater than specified in Table 14.1.

Exception No. 1: A material with a PLC for HAI greater than specified in Table 14.1 is capable of being used when the spacing over the surface of the material is not less than 1/2 in (12.7 mm):

- 1) Between live parts of opposite polarity,*
- 2) Between live parts and grounded noncurrent-carrying metal, and*
- 3) Between live parts and exposed noncurrent-carrying metal.*

Exception No. 2: A material with a PLC for HAI greater than specified in Table 14.1 is capable of being used when the material complies with End-Product Arc Resistance, Section 56.

Exception No. 3: A material with a PLC for HWI greater than specified in Table 14.1 is capable of being used when the material complies with Abnormal Overload, Section 54.

Table 14.1
Material property

Material property (units)	Flame class of material			
	V-0	V-1	V-2	HB
HAI (PLC)	3	2	2	1
HWI (PLC)	4	3	2	2

14.4 A thermoplastic material used to support a live part shall be subjected to the conditioning described in 54.1.2. As a result of the conditioning, the spacings specified in Spacings, Section 26, and Spacings to Polymeric Enclosures, Section 26.2, shall be maintained and live parts shall remain reliably secured in place.

14.5 A small molded part, such as a brush cap, shall be constructed to have the necessary mechanical strength and rigidity to withstand the stresses of actual service. A brush cap shall be secured or located so that it is protected from mechanical damage that may result during intended use.

15 Internal Wiring

15.1 Mechanical protection

15.1.1 Wiring and connection between parts of an appliance shall be protected or enclosed.

Exception: A length of flexible cord may be employed for external connections if flexibility is essential.

15.1.2 Wires within an enclosure, a compartment, a raceway, or the like, shall be routed or otherwise protected so that damage to conductor insulation cannot result from contact with any rough, sharp, or moving part.

15.1.3 A hole through which insulated wires pass in a sheet-metal wall within the overall enclosure of an appliance shall be provided with a smooth, rounded bushing or shall have smooth, rounded surfaces upon which the wires may bear.

15.1.4 A flexible cord used for external interconnection as mentioned in the exception to 15.1.1 shall be provided with strain relief and bushings in accordance with the requirements in 12.1.2.1 – 12.1.3.8, and Section 48, Strain-Relief Test, unless the construction is such that the cord will be protected from stress and motion.

15.1.5 Insulated wires may be bunched and passed through a single opening in a metal wall within the enclosure of an appliance.

15.1.6 A conductor utilizing beads for insulation shall not be employed outside an enclosure.

15.1.7 Internal wiring shall consist of wires of a type or types that are acceptable for the application, when considered with respect to the temperature and voltage to which the wiring is likely to be subjected and with respect to its exposure to oil, grease, or other conditions of service to which it is likely to be subjected.

15.1.8 Thermoplastic-insulated wire employed for internal wiring shall be standard building wire or appliance-wiring material acceptable for the purpose.

15.1.9 With reference to exposure of insulated wiring through an opening in the enclosure of an appliance, the protection of such wiring required by 15.1.1 is considered to exist if, when judged as though it were film-coated wire, the wiring would be acceptable according to 11.1. Internal wiring not so protected may be accepted if it is secured within the enclosure so that it is unlikely to be subjected to stress or mechanical damage.

15.1.10 Wiring that may be located in proximity to combustible material or may be subjected to mechanical damage shall be in armored cable, rigid metal conduit, electrical metallic tubing, metal raceway, or be otherwise equivalently protected.

15.1.11 A nominal 0.110-, 0.125-, 0.187-, 0.205-, or 0.250-in wide quick-connect terminal shall comply with the requirements in the Standard for Electrical Quick-Connect Terminals, UL 310. Other sizes of quick-connect terminals shall be investigated with respect to crimp pull out, engagement-disengagement forces of the connector and tab, and temperature rise, all tests shall be conducted in accordance with the requirements in the Standard for Electrical Quick-Connect Terminals, UL 310.

15.1.11 revised June 11, 2009

15.2 Splices and connections

15.2.1 Each splice and connection shall be mechanically secure and shall provide reliable electrical contact. A soldered connection shall be mechanically secured before being soldered if breaking or loosening of the connection may result in a risk of fire or electric shock.

15.2.2 For an appliance in which vibration is likely to occur – such as a vibrator – the requirement in 15.2.1 will necessitate the use of lock washers or other equivalent means to prevent wire-binding screws and nuts from becoming loosened.

15.2.3 A splice shall be provided with insulation equivalent to that of the wires involved if permanence of spacing between the splice and other metal parts may not be maintained.

15.2.4 Aluminum conductors, insulated or uninsulated, used as internal wiring, such as for internal connection between current-carrying parts or as motor windings, shall be terminated by a method acceptable for the combination of metals involved at the point of connection.

15.2.5 With reference to the requirements in 15.2.4, a wire-binding screw or a pressure wire connector used as a terminating device shall be acceptable for use with aluminum under the conditions involved – for example, temperature, heat cycling, vibration, and the like.

15.2.6 Insulation consisting of two layers of friction tape, two layers of thermoplastic tape, or of one layer of friction tape on top of one layer of rubber tape, is acceptable on a splice. In determining if splice insulation consisting of coated-fabric, thermoplastic, or other type of tubing is acceptable, consideration is to be given to such factors as its dielectric properties, heat- and moisture-resistant characteristics, and the like. Thermoplastic tape wrapped over a sharp edge is not acceptable.

15.2.7 If stranded internal wiring is connected to a wire-binding screw, loose strands of wire shall be prevented from contacting other uninsulated live parts that are not always of the same polarity as the wire and from contacting dead metal parts. This may be accomplished by use of pressure terminal connectors, soldering lugs, crimped eyelets, soldering all strands of the wire together, or other reliable means.

16 Separation of Circuits

16.1 Conductors of circuits operating at different potentials shall be reliably separated from each other unless the conductors are each provided with insulation rated for the highest potential involved.

16.2 An insulated conductor shall be retained so that it is not capable of contact with an uninsulated live part of a circuit operating at a different potential.

17 Capacitors

17.1 A capacitor provided as a part of a motor and a capacitor connected across the line, such as a capacitor for radio-interference elimination or power-factor correction, shall be housed within an enclosure or container that will protect the plates against mechanical damage and that will prevent the emission of flame or molten material resulting from malfunction or breakdown of the capacitor. The container shall comply with the requirements in 7.1.2 and 7.1.3.

Exception: The individual container of a capacitor may be of sheet metal less than specified in 7.1.3 or may be of material other than metal if the capacitor is mounted in an enclosure that houses other parts of the appliance and provided that such housing is acceptable for the enclosure of live parts.

17.2 If a capacitor that is not a part of a capacitor motor or a capacitor-start motor is connected in an appliance that is intended to be automatically or remotely controlled so that malfunction or breakdown of the capacitor would result in a risk of fire, electric shock, or injury to persons, thermal or overcurrent protection shall be provided in the appliance to prevent such a condition.

17.3 A capacitor connected from one side of the line to the frame or enclosure of an appliance shall have a capacitance rating of not more than 0.10 mF. See 36.2.

17.4 An appliance that is intended to be controlled by or operated in conjunction with a capacitor or a capacitor/transformer unit shall be supplied with such capacitor or unit.

17.5 Under both normal and abnormal conditions of use, a capacitor employing a dielectric medium more combustible than askarel shall not cause a risk of fire or electric shock and shall be protected against expulsion of the dielectric medium.