UL 1727

STANDARD FOR SAFETY

Commercial Electric Personal Grooming Appliances

UL Standard for Safety for Commercial Electric Personal Grooming Appliances, UL 1727

Fifth Edition, Dated May 21, 2012

Summary of Topics

This revision of ANSI/UL 1727 dated April 13, 2023 includes the following changes in requirements:

– Clarification of Immersion Protection Requirements and Immersion Protection Trip Time Measurement Test; 4.3A, 4.23A, 4.28A, 8.1, 8.2, 8.5, 8.6, 8.8, 49.1.1 – 49.1.4, 49.2.1, 49.2.1, 79.9.1, and SA4.2

– Clarification of Temperature Test for Hand Supported Hair Dryers; 4.47, 4.48, 46.1.8, 46.1.8A, and Table 66.1

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 new and revised requirements are substantially in accordance with Proposal(s) on this subject dated February 28, 2023.

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UL 1727

Standard for Commercial Electric Personal Grooming Appliances

Prior to the first edition, the requirements for the products covered by this standard were included in the Standard for Electric Personal Grooming Appliances, UL 859.

First Edition – May, 1986
Second Edition – October, 1988
Third Edition – March, 1994
Fourth Edition – March, 1999

Fifth Edition

May 21, 2012

This ANSI/UL Standard for Safety consists of the Fifth Edition including revisions through April 13, 2023.

The most recent designation of ANSI/UL 1727 as an American National Standard (ANSI) occurred on April 13, 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 ULSE's Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover electric personal grooming appliances intended for use by qualified personnel in commercial establishments such as beauty parlors, barber shops, or cosmetic studios. These appliances include hair curlers and dryers, combs, brushes, and similar appliances that are to be employed in accordance with the National Electrical Code, ANSI/NFPA 70.

1.2 These requirements do not cover therapeutic lamps, diathermy equipment, massage machines, vibrators, hair clippers, shavers, facial caps, masks, mitts, or other appliances covered by other requirements such as in the Standard for Medical Electrical Equipment, Part 1: General Requirements for Safety, UL 60601-1. These requirements also do not cover hair curlers or dryers rated at more than 250 volts.

2 Units of Measurement

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

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

3 Undated References

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

4 Glossary

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

4.2 APPLIANCE COUPLER – A single-outlet, female contact device for attachment to a flexible cord as part of a detachable power-supply cord to be connected to an appliance inlet (motor attachment plug).

4.3 APPLIANCE INLET (MOTOR ATTACHMENT PLUG) – A male contact device mounted on an end product appliance to provide an integral blade configuration for the connection of an appliance coupler or cord connector.

4.3A APPLIANCE LEAKAGE-CURRENT INTERRUPTERS (ALCIs) – A device intended to interrupt the electric circuit to the load, when a fault current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

4.4 APPLIANCE (FLATIRON) PLUG – An appliance coupler type of device having a cord guard and a slot configuration specified for use with heating or cooking appliances.

4.5 AUTOMATIC CONTROL – A device intended for automatic control of operating time, temperature, or pressure under conditions of intended operation and not for protection against conditions resulting from abnormal operations.

4.6 AUTOMATICALLY CONTROLLED APPLIANCE – An appliance is considered to be automatically controlled if it complies with one or more of the following conditions:

a) The repeated starting of the appliance is independent of any manual control if, after one complete cycle of operation, a limit device or similar device opens the circuit.

b) During any single preset cycle of operation, the motor is caused to stop and restart.

c) When the appliance is energized, the initial starting of the motor may be intentionally delayed beyond intended, conventional starting.

d) For an appliance employing a motor with a separate starting winding, during any single predetermined cycle of operation automatic changing of the mechanical load reduces the motor speed sufficiently to re-establish starting-winding connections to the supply circuit.

4.7 BODY-SUPPORTED APPLIANCE – An appliance that is physically supported by any part of the body, other than the hand of the user, during the performance of its intended electrically operated functions (such as a shoulder-, body-, or head-supported hair dryer) is to be considered a body-supported appliance. Reference is to be made to the user manual of the appliance in establishing the intended electrically operated functions of the appliance.

4.8 CONTINUOUS-DUTY MOTOR – A motor that can operate unattended and under load under any normal conditions of use for 3 hours or more.

4.9 CONTROL, AUTOMATIC ACTION – A control in which at least one aspect is non-manual.

4.10 CONTROL, AUXILIARY – A device or assembly of devices that provides a functional utility, is not relied upon as an operational or protective control, and therefore is not relied upon for safety. For example, an efficiency control not relied upon to reduce the risk of electric shock, fire, or injury to persons during normal or abnormal operation of the end product is considered an auxiliary control.

4.11 CONTROL, MANUAL – A device that requires direct human interaction to activate or reset the control.

4.12 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 reduce the risk of electric shock, fire, or injury to persons, is considered an operating control.

4.13 CONTROL, PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of electric shock, fire or injury to persons during 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” and “safety controls.”

Note – During the testing of the protective control/circuit, the protective functions are verified under normal and single-fault conditions of the control.

4.14 CONTROL, TYPE 1 ACTION – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence has not been declared and tested under this standard.

4.15 CONTROL, TYPE 2 ACTION – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence have been declared and tested under this standard.

4.16 CORD CONNECTOR – A female contact device wired on flexible cord for use as an extension from an outlet to make a detachable electrical connection to an attachment plug or, as an appliance coupler, to an equipment inlet.

4.17 COUNTER-SUPPORTED APPLIANCE – An appliance that is physically supported by a counter, table, or bench during the performance of its intended electrically operated functions (such as a hair curler heater) is considered a counter-supported appliance. Reference is to be made to the user manual of the appliance in establishing the intended electrically operated functions of the appliance.

4.18 DEAD-METAL PART – A metal or other electrically conductive part, accessible or inaccessible, that is not conductively connected to a live part.

4.19 DIRECT PLUG-IN APPLIANCE – An appliance, without a power supply cord, that is physically supported by direct insertion of its integral blades into a receptacle is considered a direct plug-in appliance.

4.20 DIRECTLY ACCESSIBLE MOTOR – A motor that:

a) Can be contacted without opening or removing any part of an enclosure or guard or

b) Is located so as to be accessible to contact.

4.21 DUAL-VOLTAGE APPLIANCE – An appliance rated for use on a supply circuit of either of two different voltages (for example, 120 volts and 240 volts) and usually provided with a means to change from one voltage to the other.

4.22 FIXED APPLIANCE – An appliance intended to be permanently connected electrically.

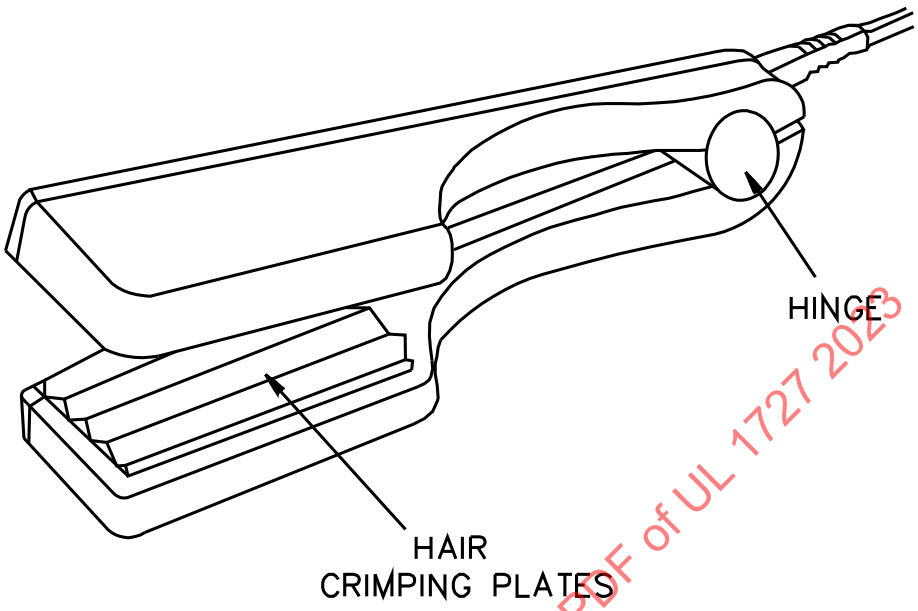
4.23 FLOOR-SUPPORTED APPLIANCE – An appliance that is physically supported by the floor during the performance of its intended electrically operated functions (such as hair dryers with roll-about stands) is considered a floor-supported appliance. Reference is to be made to the user manual of the appliance in establishing the intended electrically operated functions of the appliance.

4.23A GROUND-FAULT CIRCUIT-INTERRUPTER (GFCI) – A device intended for the protection of personnel that functions to de-energize a circuit, within an established period of time, when a fault current to ground, exceeds some predetermined value, that is less than that required to operate the overcurrent protective device of the supply circuit.

4.24 HAIR-CRIMPING IRON – A hand-supported hair curling appliance having hinged arms and ridged or wavy surfaced electrically heated tongs between which hair is curled. A typical construction is shown in Figure 4.1.

Figure 4.1

Typical hair-crimping iron



4.25 HAIR CURLER HEATER (HAIR SETTER) – A counter-supported appliance having posts or wells on or in which hair curling devices (rollers and the like) are heated before being applied to the hair. The term also applies to a construction that has individual electrical hair curlers (rollers) with built-in heating elements and male electrical fittings which plug into female contacts in the appliance.

4.26 HAIR-STRAIGHTENING IRON – An appliance similar to a hair-crimping iron as described in 4.24 except that the hair-crimping plates are replaced with flat plates.

4.27 HAND-HELD APPLIANCE, HAND-GUIDED APPLIANCE – A portable appliance that during intended use is contacted by the hand of the user for purposes of electrical or physical control but not for complete support.

4.28 HAND-SUPPORTED APPLIANCE – An appliance that is physically supported by the hand of the user during the performance of its intended functions (such as a curling iron) is considered a hand-supported appliance. Reference is to be made to the user manual of the appliance in establishing the intended electrically operated functions of the appliance.

4.28A HAND-SUPPORTED HAIR DRYING APPLIANCE – An hand supported appliance noted in 4.28, intended to blow or dry wet hairs and may include additional hair styling functions. Hand supported hair drying appliance includes hair dryer, blower-styler, heated-air curler, heated air curling iron, curling iron-hair dryer combination, a wall hung hair dryer or the hand unit of a wall-mounted hair dryer, or similar appliance.

4.29 HEATED-AIR CURLING IRON (or BRUSH) – A curling iron (or brush) in which a fan included in the appliance blows air over the heating elements and out through openings in the barrel of the appliance.

4.30 HIGH-VOLTAGE CIRCUIT – A circuit involving a potential of more than 600 volts.

4.31 INDIRECTLY ACCESSIBLE MOTOR – A motor that is 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 a motor that is located or otherwise guarded or enclosed so that it is unlikely to be contacted.

4.32 INPUT VOLTAGE SELECTOR – The means provided on an appliance to adjust for the available input voltage.

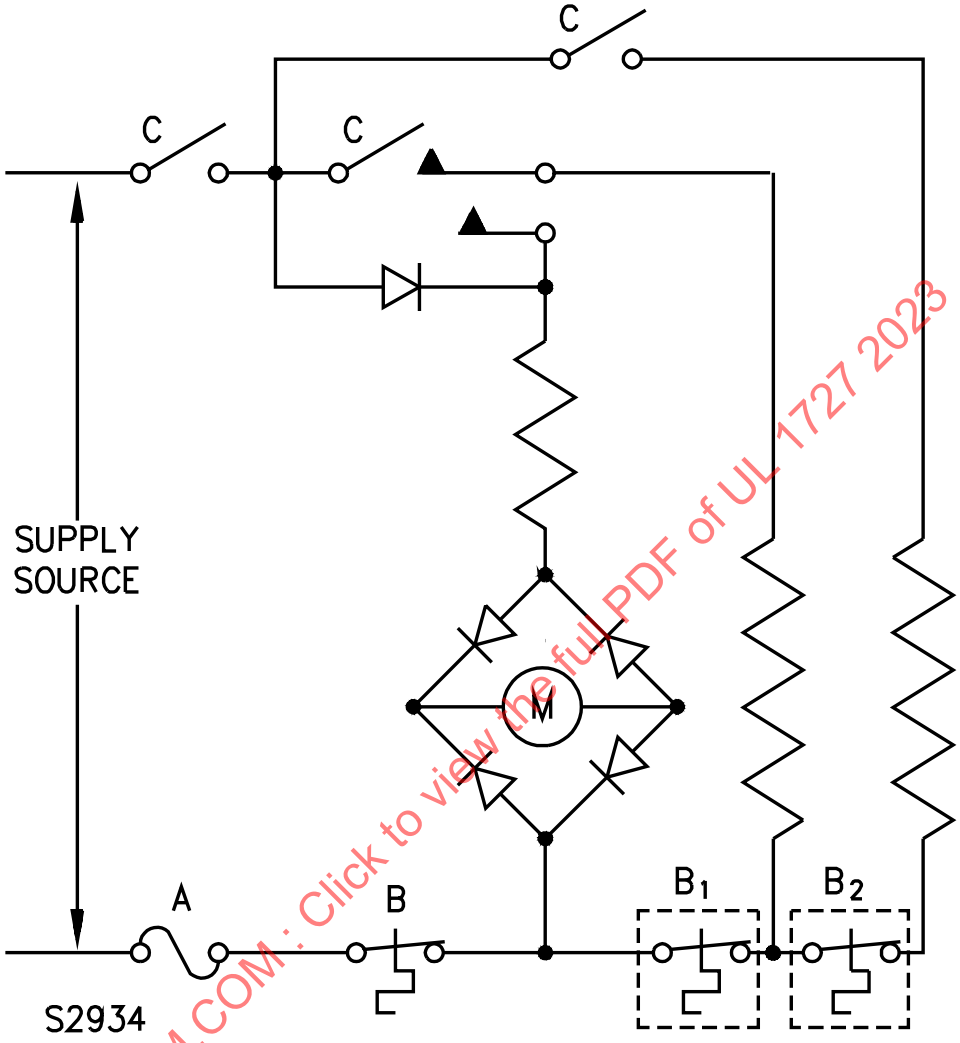
4.33 INTERLOCK – A device that automatically de-energizes electrical components or stops moving parts that become exposed when an enclosure is opened or when a cover is removed.

4.34 ISOLATING TRANSFORMER – A transformer of which one or more output windings is electrically separated from the input winding.

4.35 LIMIT CONTROL – As applicable to hand-supported hair dryers, a limit control, as shown in note A of Figure 4.2, is a non-resettable control (a control intended to operate only once; that is, the control is not intended to be nor can it be reset or reconditioned for reuse) that operates to open all electrical circuits to reduce the risk of fire or electric shock.

Figure 4.2

Typical hair dryer circuit



A – Limit control (a non-resettable device, as defined in 4.35).

B – Temperature control (a calibrated automatic-reset device, as defined in 4.47). See also 46.1.23 and 46.1.24.

B_1, B_2 – Temperature control (a calibrated automatic-reset device, as defined in 4.47) shown at two other locations. See also 46.1.23 and 46.1.24.

C – Switches.

M – Motor.

4.36 LIMITED-ENERGY PRIMARY CIRCUIT – A line-voltage circuit that incorporates a limiting impedance in series with the supply circuit so that:

a) The circuit potential on the load side of the limiting impedance does not exceed 42.4 volts peak (30 volts rms), under intended conditions and

b) The maximum energy available at the load side of the limiting impedance circuit is 100 volt-amperes under any condition, including abnormal operation.

4.37 LINE-VOLTAGE CIRCUIT – A circuit involving a potential of no more than 250 volts and having circuit characteristics in excess of those of a low-voltage circuit or a limited-energy primary circuit.

4.38 LIVE PART – A part energized with respect to earth or to some other part.

4.39 LOW-VOLTAGE CIRCUIT – A circuit supplied by a primary battery, by a Class 2 transformer, or by a combination of a transformer and fixed impedance that, as a unit, complies with all performance requirements for Class 2 transformers and that does not involve an open circuit potential of more than 42.4 volts peak (30 volts rms).

4.40 ORDINARY TOOL – A flat blade or Phillips head screwdriver, wrench, pliers, or other simple tool that is readily available.

4.41 PORTABLE APPLIANCE – An appliance capable of being carried or conveyed.

4.42 PREHEAT CYCLE – A cycle of operation in which the heating element initially operates at a higher wattage for a predetermined length of time at the end of which the wattage drops to a lower continuous operation level. The preheat cycle may or may not be repeated during a use of the appliance. The temperature transient condition associated with the operation of a positive temperature coefficient (PTC) heating element is not considered to be a preheat cycle.

4.43 REMOTELY-CONTROLLED APPLIANCE – An appliance that is out of view of the operator at the starting device.

4.44 SAFETY CIRCUIT – Any circuit, either in the primary or secondary, that is relied upon to reduce the risk of fire, electric shock, or injury to persons; for example, an interlock circuit is considered a safety circuit.

4.45 SECONDARY CIRCUITS – Circuits supplied from the secondary windings of isolating transformers. See 36.1.1 – 36.2.2.

4.46 STATIONARY APPLIANCE – A cord-connected appliance that is intended to be fastened in place or located in a dedicated space.

4.47 TEMPERATURE CONTROL – As applicable to hand-supported hair dryers, a temperature control, as shown in note B of Figure 4.2, is an automatic-reset temperature-sensing control that operates to open an electrical circuit to limit temperatures during motor slowdown and abnormal operation. A temperature control is a calibrated control that is intended for at least 6000 cycles of operation and that complies with all other requirements in the Standard for Limit Controls, UL 353, or in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873 or in the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9. See also 32.2.2.

4.48 TEMPERATURE-LIMITING CONTROL – A control that functions only under conditions that produce temperatures higher than intended. The breakdown of the control might or might not result in a risk of fire, electric shock, or injury to persons.

4.49 TEMPERATURE-REGULATING AND -LIMITING CONTROL – A combination control that functions to regulate the temperature of the appliance under conditions of intended use, and also serves to reduce the risk of electric shock or injury to persons that might result from higher than intended temperatures.

4.50 TEMPERATURE-REGULATING CONTROL – A control that functions only to regulate the temperature under conditions of intended use. The breakdown of the control would not result in a risk of fire, electric shock, or injury to persons.

4.51 THERMAL CUTOFF – A temperature or temperature- and current-sensitive device incorporating a thermal element for protecting a circuit by opening the protected circuit when the device reaches a predetermined temperature. It is intended to reduce the risk of fire, electric shock, or injury to persons due to overheating of an appliance during abnormal operation and to operate only once, that is, it cannot be reset or reconditioned for reuse.

4.52 WALL-HUNG APPLIANCE – A cord-connected appliance that is provided with concealed (see 9.7.2) keyhole slots, hanger holes, or the like in order to be hung on a wall and that does not require the use of tools for removal from the wall. A wall-hung appliance may consist of two interconnected units where one is intended to hang on a wall and the other is intended to be supported by hand during use.

4.53 WALL-MOUNTED APPLIANCE – An appliance that is permanently attached to a wall surface, and connected electrically.

4.54 WIRING TERMINAL – A terminal to which power supply or control connections are to be made in the field when the appliance is installed.

5 Types of Appliances

5.1 In the following text, a requirement that applies only to a specific type or types of appliances, such as a hand-supported hair dryer and a curling iron, is so identified by specific reference in that requirement to the type or types involved. Absence of such specific reference or use of the term "appliance" indicates that the requirement applies to all appliances covered by this standard.

5.2 An appliance that is a combination of two or more types (for example, an appliance having a hand-supported part and a counter-supported part) or an appliance that fits the definition of two or more types (for example, an appliance that can be used while supported by hand or while supported by countertop) is investigated in accordance with the applicable requirements for the types of appliances involved. If two requirements that address the same condition differ, the appliance is investigated to the more severe requirement.

CONSTRUCTION

6 Components

6.1 A component of a product covered by this standard shall:

a) Comply with the requirements for that component as indicated in the individual section(s) 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;

d) Additionally comply with the applicable requirements of this standard; and

e) Not contain mercury, unless used within a fluorescent, high intensity discharge, or neon lamp bulb.

Exception No. 1: 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.

Exception No. 2: A component complying with a component standard other than those cited in this standard is acceptable if:

a) The component also complies with the applicable component standard indicated in this standard or

b) The component standard:

1) Is compatible with the ampacity and overcurrent protection requirements of the National Electrical Code, ANSI/NFPA 70, where appropriate;

2) Considers long-term thermal properties of polymeric insulating materials in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B; and

3) Any use limitations of the other component standard is identified and appropriately accommodated in the end use application. For example, a component used in a household application, but intended for industrial use and complying with the relevant component standard may assume user expertise not common in household applications.

6.2 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.

6.3 A component that is also intended to perform other functions, such as:

a) Overcurrent protection;

b) Ground-fault circuit-interruption;

c) Surge suppression;

d) Any other similar functions; or

e) Any combination thereof

shall comply additionally with the requirements of the applicable UL standard(s) that cover devices that provide those functions.

Exception: Where these other functions are not required for the application and not identified as part of markings, instructions, or packaging for the appliance, the additional component standard(s) need not be applied.

6.4 A component not anticipated by the requirements of this standard, not specifically covered by the component standards noted in this Standard, and that involves a risk of fire, electric shock, or injury to persons, shall be additionally investigated in accordance with the applicable UL standard, and shall comply with 6.1 (b) – (e).

6.5 With regard to a component being additionally investigated, reference to construction and performance requirements in another UL end product standard is suitable where that standard anticipates normal and abnormal use conditions consistent with the application of this standard.

7 Stands

7.1 An appliance such as a curling iron that can be placed on combustible material shall be provided with a stand made of material resistant to combustion, upon which the curling iron can be placed when not in use.

Exception No. 1: A stand is not required to be provided if the temperature attained on any external surface of the appliance that is likely to contact the supporting surface is not higher than 90°C (194°F).

Exception No. 2: A hand-supported hair dryer is not required to be provided with a stand.

7.2 If an appliance as described in 7.1 attains a temperature higher than 100°C (212°F) on an external surface that is likely to contact the supporting surface when operated continuously, it shall be provided with an integral stand. A stand provided for other types of appliances may be provided either as a separate device or integral with the appliance.

7.3 With respect to 7.2, an integral stand provided with an appliance shall be of such construction or shape that any surface of the appliance exceeding 150°C (302°F) does not contact the supporting surface when the appliance is supported by the stand in the intended manner.

7.4 A polymeric material employed as an integral stand in compliance with the requirements in 7.3 shall be rated for the temperature to which it will be subjected during use.

7.5 A heated-air curling iron or brush, as defined in 4.29, shall comply with the requirements applicable to hand-supported hair dryers and curling irons.

8 Hair Dryer Immersion Protection

8.1 A hand-supported, hair-drying appliance specified in 4.28A shall be constructed to reduce the risk of electric shock when the appliance is energized with its power switch in either the "on" or "off" position and the unit is immersed in water having an electrically conductive path to ground.

8.2 Compliance with 8.1 may be accomplished with the use of an:

a) Integral ground-fault circuit-interrupter (GFCI),

b) Appliance leakage-current interrupter (ALCI), or

c) Integral protective device of another type that de-energizes all current-carrying parts (hereafter referred to as a protective device) when the hand-supported hair-drying appliance is immersed in water having an electrically conductive path to ground.

8.3 When a hand-supported, hair-drying appliance is provided with a GFCI, the GFCI shall comply with the requirements for Class A cord-connected GFCIs in the Standard for Ground-Fault Circuit-Interrupters, UL 943.

Exception: A GFCI located in the wall unit of a wall-mounted, permanently-connected hair dryer shall comply with the requirements for Class A, permanently-connected GFCIs in UL 943.

8.4 If a hand-supported, hair-drying appliance is provided with a protective device other than a GFCI, the protective device shall be acceptable for the application. Investigation of the protective device shall include and is not required to be limited to consideration of:

a) Electrical rating,

b) Operating temperatures,

c) Reliability of operation,

d) Resistance to the effects of abnormal operating conditions,

e) Resistance to mechanical abuse,

f) Resistance to electrical transients, and

g) Resistance to moisture.

The combination of hair-drying appliance and protective device shall comply with the test described in the Immersion Protection Trip Time Measurement Test, Section 49.

Exception No. 1: A protective device is deemed acceptable for the application if it complies with the requirements for Class A cord-connected GFCIs in the Standard for Ground-Fault Circuit-Interrupters, UL 943, except that it is not required to:

a) Have a grounding conductor;

b) Have the same type of power supply cord;

c) Comply with the high-resistance ground faults test under the condition that any power conductor is open-circuited; or

d) Provide grounded neutral protection by compliance with the high-resistance ground faults test, under the test condition that the neutral conductor is grounded at a point in the load circuit.

Exception No. 2: A protective device is deemed acceptable for the application if it complies with the requirements in the Standard for Appliance Leakage-Current Interrupters, UL 943B. The combination of a hand-supported, hair-drying appliance and such a protective device is not required to be subjected to the test described in the Immersion Protection Trip Time Measurement Test, Section 49.

8.5 A GFCI or other protective device shall be integral with the plug of the hand-supported, hair-drying appliance power supply cord.

Exception No. 1: For a wall-mounted, permanently-connected hair dryer, the GFCI or other protective device may be located in the wall unit.

Exception No. 2: A GFCI or other protective device may be located in the wall hung unit of hair dryer enclosure after additional investigations with regard to acceptability after immersion, resistance to mechanical abuse, and similar considerations.

8.6 A user-resettable protective device shall incorporate a supervisory circuit as described in the Standard for Ground-Fault Circuit-Interrupters, UL 943, for GFCIs. See 8.8.

Exception: A user-resettable protective device may be provided with a reset feature not providing a test function if:

a) The protective device complies with the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991. If the computational investigation is conducted, the maximum predicted failure rate (Δp) shall not exceed 1.5 failures per million hours predicted. If the demonstrated method is conducted, the test acceleration multiplier shall be 5763;

b) The instructions provided with the appliance alert the user to the reset feature and how and when to use it; and

c) The instructions provided with the appliance alert the user to not reset and reuse the appliance should the protective device trip as a result of immersion.

8.7 A switch included for testing a user-resettable protective device shall be permanently marked "Test" and "Reset" on or adjacent to the switch actuators.

8.8 After a protective device de-energizes current-carrying parts, it shall not automatically reset. Hand supported hair-drying appliances shall have a user resettable protective device.

9 Frame and Enclosure

9.1 General

9.1.1 The frame and enclosure of an appliance shall be sufficiently strong and rigid to resist the abuses likely to be encountered during service. The degree of resistance inherent in the appliance shall preclude total or partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other conditions which alone or in combination constitute an increase in the risk of fire, electric shock, or injury to persons.

9.1.2 Among the factors taken into consideration in evaluating an enclosure for acceptability are its:

a) Physical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Combustibility;

e) Resistance to corrosion; and

f) Resistance to distortion at temperatures to which the enclosure may be subjected under conditions of normal or abnormal use.

For a nonmetallic enclosure, all these factors are considered with regard to thermal aging.

9.2 Polymeric enclosures and parts

9.2.1 A polymeric enclosure shall comply with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. A direct plug-in appliance shall comply with the requirements for unattended portable appliances in UL 746C.

9.2.2 A enclosure or part relied upon for compliance with this standard, when fabricated from polymeric materials, shall have clear traceability as to composition, ingredients, and processing for the fabricated part to the extent that the composition, ingredients, or process impacts the compliance of the product. Fabricated parts complying with the Standard for Polymeric Materials – Fabricated Parts, UL 746D meets this requirement.

9.3 Metal enclosures

9.3.1 The minimum thickness of a metal enclosure shall be as indicated in Table 9.1.

Table 9.1
Minimum thickness of enclosure metal

Metal	At small, flat, unreinforced surfaces and at surfaces that are reinforced by curving, ribbing, and the like (or are otherwise of a shape or size) to ensure adequate physical strength,		At surfaces to which a wiring system is to be connected in the field,		At relatively large unreinforced flat surface,	
	inch	(mm)	inch	(mm)	inch	(mm)
Die-cast	3/64	(1.2)	–	–	5/64	(2.0)
Cast malleable iron	1/16	(1.6)	–	–	3/32	(2.4)
Other cast metal	3/32	(2.4)	–	–	1/8	(3.2)
Uncoated sheet steel	0.026[a]	(0.66)	0.032	(0.81)	0.026	(0.66)
Galvanized sheet steel	0.029[a]	(0.74)	0.034	(0.86)	0.029	(0.74)
Nonferrous sheet metal	0.036[a]	(0.91)	0.045	(1.14)	0.036	(0.91)

[a] Thinner sheet metal may be used if found to be acceptable when the enclosure is judged under considerations such as those mentioned in 9.1.2.

9.4 Accessibility of live parts

9.4.1 To reduce the risk of unintentional contact that may involve a risk of electric shock from an uninsulated live part or film-coated wire, an opening in an enclosure shall comply with either (a) or (b).

a) For an opening that has a minor dimension (see 9.4.5) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 9.1.

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 9.2.

Exception: A motor other than one used in either a hand-supported appliance or a hand-supported portion of an appliance is not required to comply with these requirements if it complies with the requirements in 9.4.2.

Figure 9.1

Articulated probe with web stop

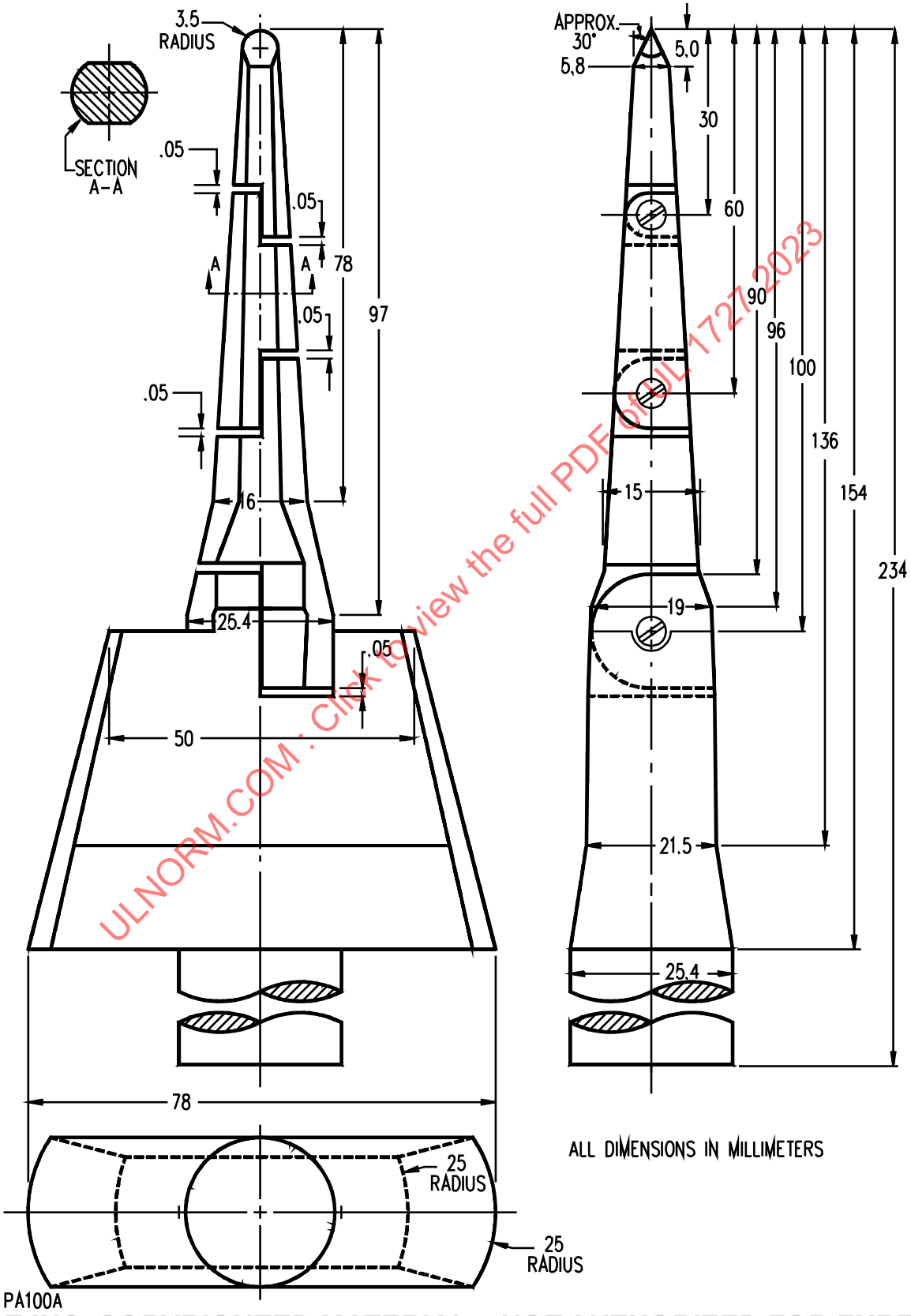


Table 9.2
Minimum distance from an opening to a part that may involve a risk of electric shock or injury to persons

Minor dimension[a,b] of opening,		Minimum distance from opening to part,[b]	
inches	(mm)	inches	(mm)
3/4[c]	(19.1)	4-1/2	(114.3)
1[c]	(25.4)	6-1/2	(165.1)
1-1/4	(31.8)	7-1/2	(190.5)
1-1/2	(38.1)	12-1/2	(317.5)
1-7/8	(47.6)	15-1/2	(393.7)
2-1/8	(54.0)	17-1/2	(444.5)
d	d	30	(762.0)

[a] See 9.4.5.

[b] Between 3/4 inch (19.1 mm) and 2-1/2 inches (63.5 mm), interpolation is to be used to determine a value between values specified in the table.

[c] Any dimension less than 1 inch (25.4 mm) applies to a motor only.

[d] More than 2-1/2 inches, but not more than 6 inches (152.4 mm).

9.4.2 Uninsulated live parts or film-coated wire of a motor as mentioned in the Exception to 9.4.1 shall comply with either (a) or (b).

a) For an opening with a minor dimension (see 9.4.5) less than 3/4 inch (19.1 mm):

1) Film-coated wire shall not be contacted by the probe illustrated in Figure 9.2;

2) In a directly accessible motor (see 4.20), an uninsulated live part shall not be contacted by the probe illustrated in Figure 9.3; and

3) In an indirectly accessible motor (see 4.31), an uninsulated live part shall not be contacted by the probe illustrated in Figure 9.4.

b) For an opening with a minor dimension of 3/4 inch or more, a part or wire shall be spaced from the opening as specified in Table 9.2.

9.4.3 The probes mentioned in 9.4.1 and 9.4.2 and illustrated in Figure 9.1 – Figure 9.4 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 9.1 and Figure 9.3 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

Figure 9.2

Probe for film-coated wire

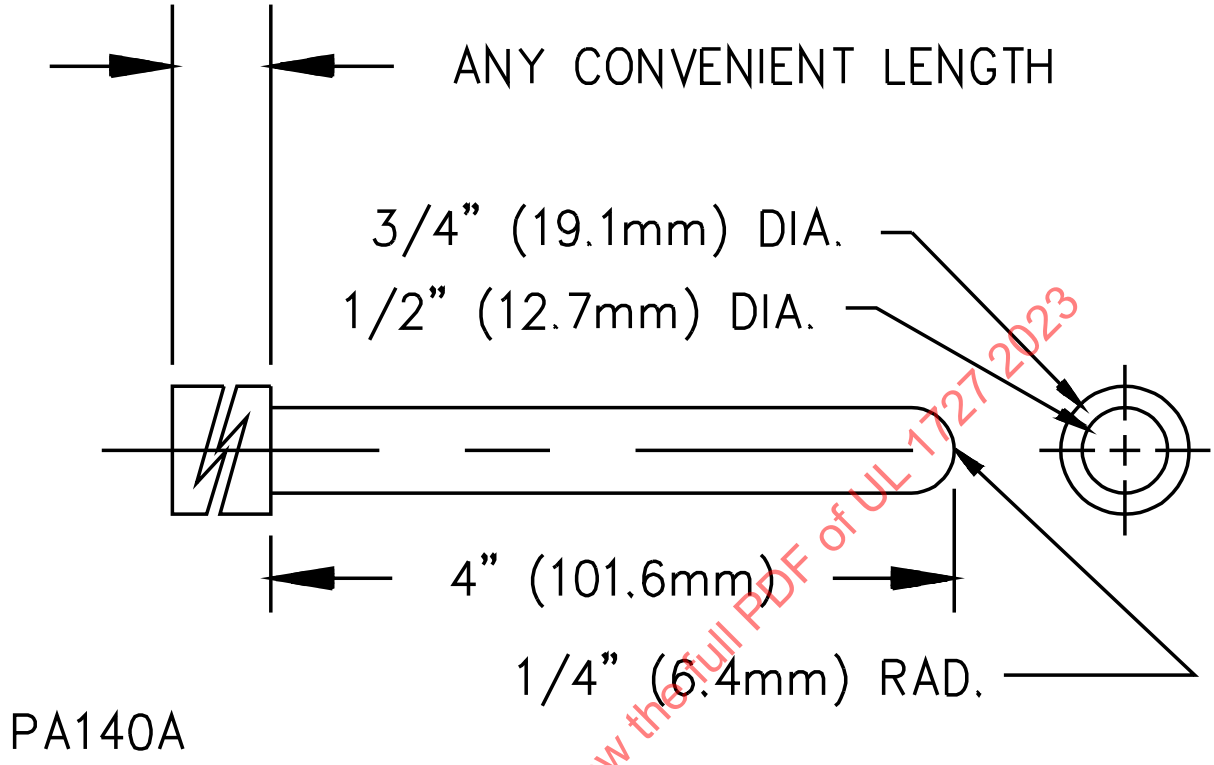


Figure 9.3

Articulated probe

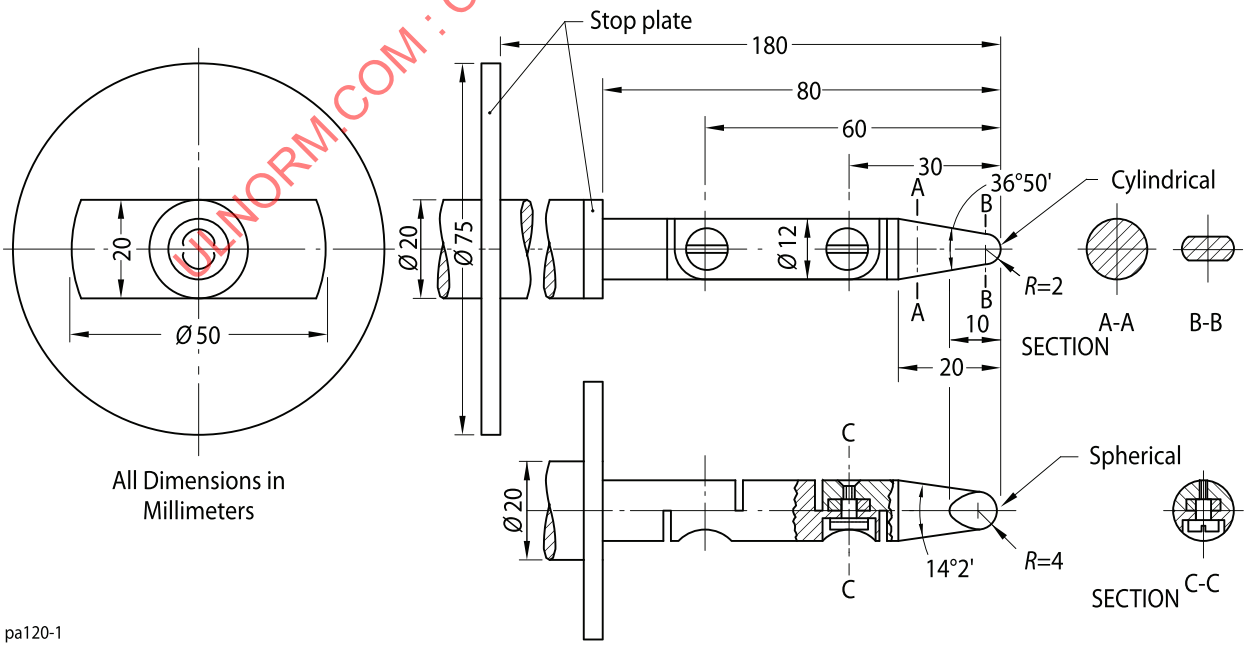
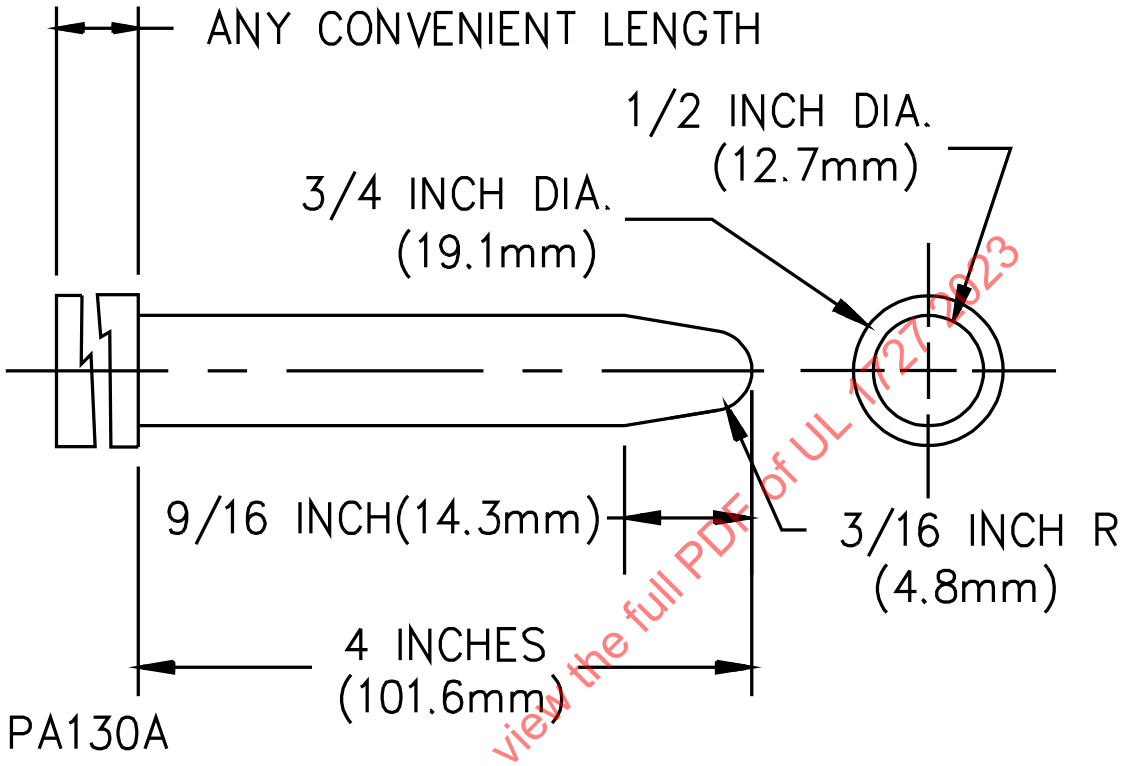


Figure 9.4

Probe for uninsulated live parts



9.4.4 The probes mentioned in 9.4.1 and 9.4.2 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.

9.4.5 With reference to the requirements in 9.4.1 and 9.4.2, 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.

9.4.6 During the examination of an appliance to determine whether it complies with the requirements in 9.4.1 or 9.4.2 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, to replace a fuse, or for other reasons) is to be opened or removed.

9.4.7 With reference to the requirements in 9.4.1 and 9.4.2, insulated brush caps are not required to be additionally enclosed.

9.4.8 A live part of a limited-energy primary circuit is considered to require the same degree of protection against unintentional contact as is required of a live part of a line-voltage circuit.

9.5 Enclosure integrity

9.5.1 An area of an enclosure that is provided with a group of openings or with a guarded opening (such as a grille, louver, or screen) which may affect intended strength of the enclosure is to be subjected to the test described in 56.1.

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

9.5.3 The requirement in 9.5.2 requires the use of a barrier of material that is resistant to combustion:

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) Main winding opened;

ii) Starting winding opened;

iii) Starting switch short-circuited; and

iv) For a permanent split capacitor motor, the capacitor short-circuited (the short circuit is to be applied before the motor is energized, and the rotor is to be locked);

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 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.

b) Under wiring, unless the wiring is provided with:

1) Flame-retardant rating VW-1 (FR-1); or

2) Wiring contained within sleeving rated VW-1.

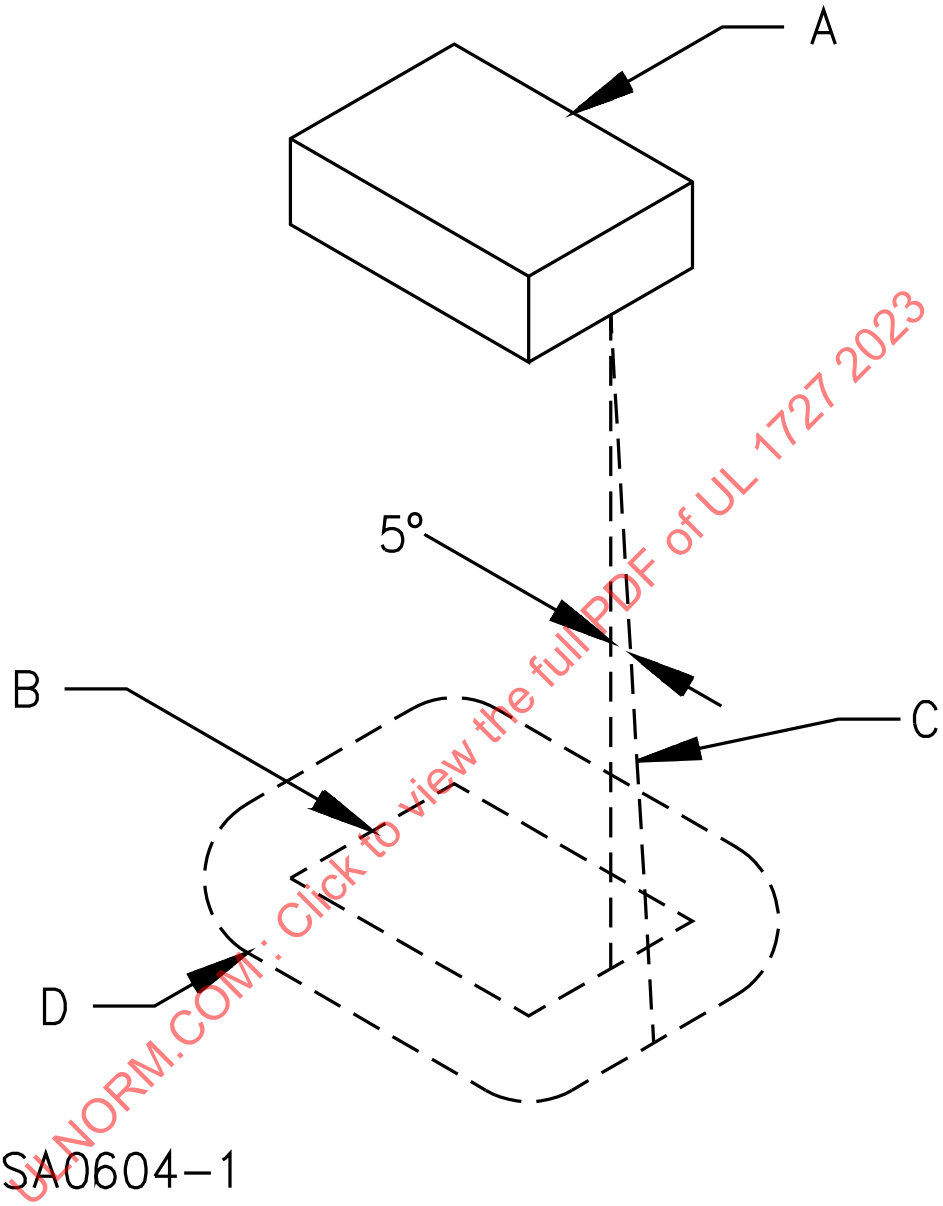
9.5.4 The requirement in 9.5.3 also requires that a switch, relay, solenoid, or similar part be individually and completely enclosed unless there is no opening in the bottom of the appliance enclosure, or it can be shown that malfunction of the component would not result in a risk of fire.

Exception: Terminals of a switch, relay, solenoid, or similar device is not required to be individually and completely enclosed.

9.5.5 The barrier mentioned in 9.5.3 shall be horizontal, shall be located as indicated in Figure 9.5 and shall have an area not less than that described in Figure 9.5. An opening for drainage, ventilation, or the like may be employed in the barrier when such an opening would not permit molten metal, burning insulation, or similar material to fall on combustible material.

Figure 9.5

Location and extent of barrier



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 which traces out minimum area of barrier. The line is always:

a) Tangent to the component,

b) 5 degrees from the vertical, and

c) 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.

9.6 Doors and covers

9.6.1 If a door or cover in an outer enclosure gives access to uninsulated live parts in a circuit (other than a low-voltage circuit), it shall be removable only with the use of tools or shall be provided with an interlocking mechanism. See 9.6.2, 9.6.6, and 9.6.7.

9.6.2 An interlocking mechanism complies with the requirements in 9.6.1 if it:

a) Secures the cover in the closed position when engaged and

b) Must be engaged before parts in the circuit can be energized.

9.6.3 The assembly shall be arranged so that an overcurrent protective device such as a fuse, the intended protective functioning of which requires renewal, can be replaced and manual-reset devices can be reset without removal of parts other than the doors or covers and without removal of the cover or door enclosing the device.

9.6.4 A required protective device shall be accessible from outside the appliance only by opening a door or cover.

Exception: The operating handle of a circuit breaker, the operating button of a manually operable protector, and similar parts may project outside the enclosure.

9.6.5 A door or cover of an enclosure shall be hinged or attached in an equivalent manner if:

a) It gives access to fuses or any motor overload protective device, the intended functioning of which requires renewal or

b) It must be opened in connection with the intended operation of the protective device, such as the resetting of a manual reset overload protective device.

9.6.6 A required hinged cover shall not depend solely upon screws or similar means to hold it closed, but shall be provided with an automatic latch or the equivalent and shall be tight-fitting or shall overlap the surface of the enclosure around the opening.

9.6.7 Compliance with the requirements of 9.6.6 may be achieved by use of:

a) A spring latch, a magnetic latch, a dimple, or equivalent mechanical arrangement that will hold the door in place and that will require some physical effort on the user's part to open or

b) A cover interlocking mechanism, as described in 9.6.2 and provided as the sole means for securing the cover or panel.

9.7 Hanging and mounting means

9.7.1 A wall-hung or a wall-mounted appliance shall withstand a force as described in 57.1 without evidence of damage to the mounting surface, to the hanging means, to the mounting means, or to the appliance that results in the risk of electric shock, fire, or injury to persons.

9.7.2 A cord-connected appliance that is provided with keyhole slots, notches, hanger holes, or the like, for hanging the appliance on a wall, shall be provided with the necessary hardware for hanging the appliance in accordance with the installation instructions and constructed in such a manner that the hanging means (such as screws) shall not be accessible without removing the appliance from the supporting means.