UL 1727

STANDARD FOR SAFETY

Commercial Electric Personal Grooming Appliances

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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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ANSI/UL 1727-2023

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.

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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:

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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.

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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.

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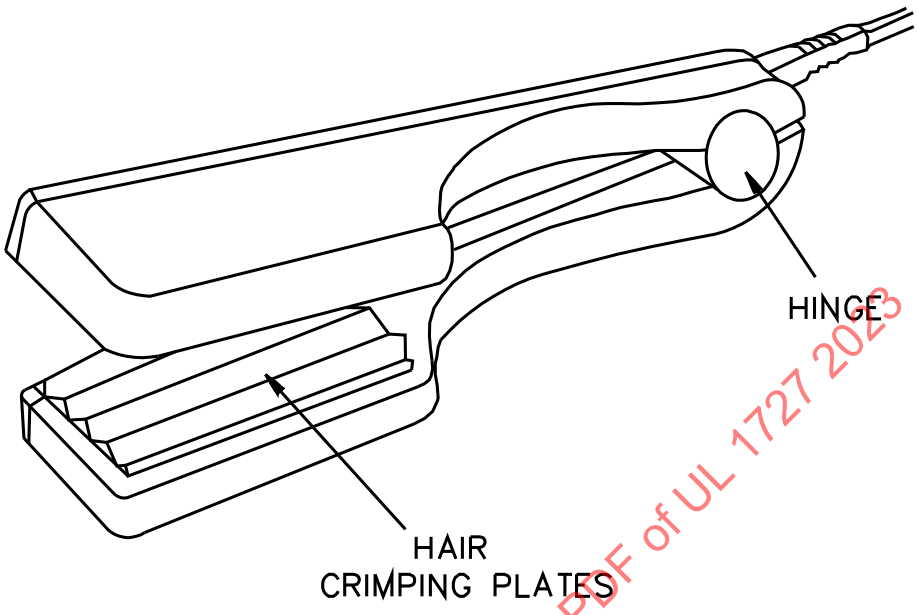
Figure 4.1

Typical hair-crimping iron



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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.

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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.

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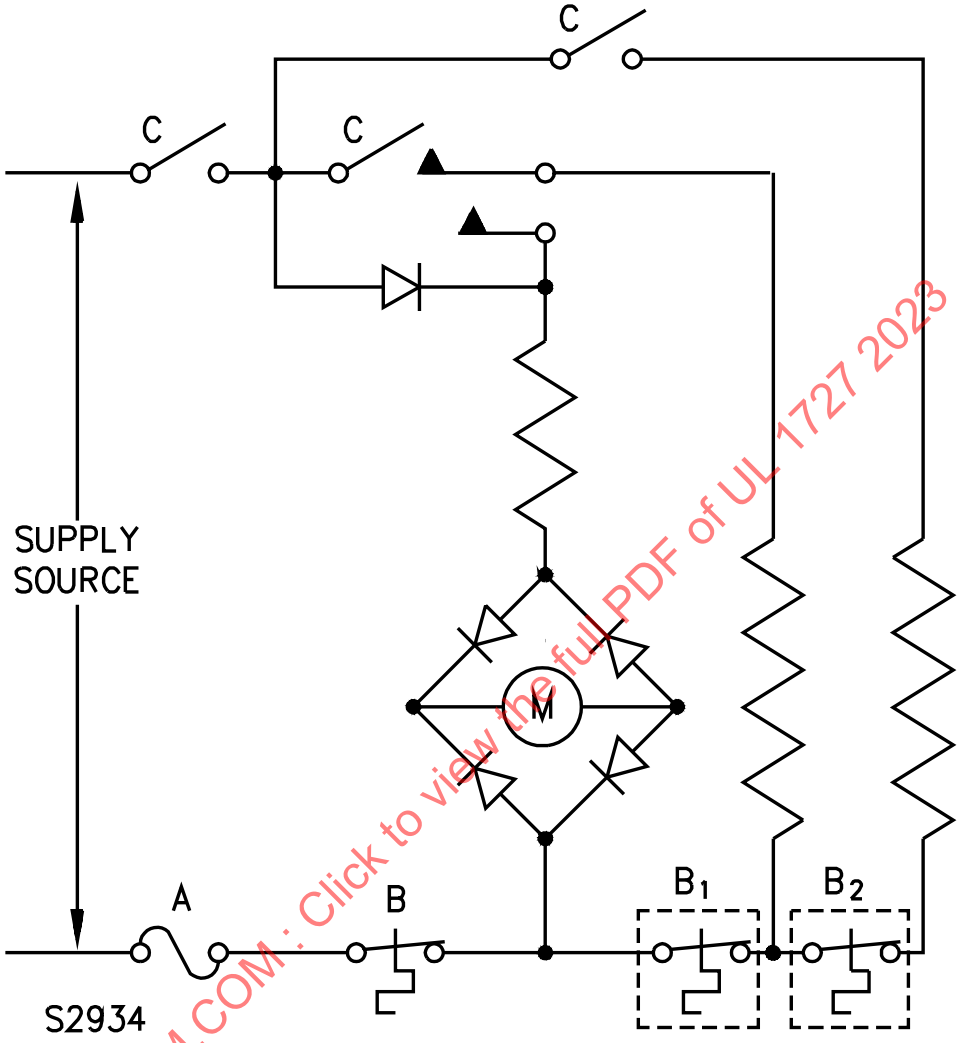
Figure 4.2

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.

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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.

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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;

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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.

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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.

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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.

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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.

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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.

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Figure 9.1

Articulated probe with web stop

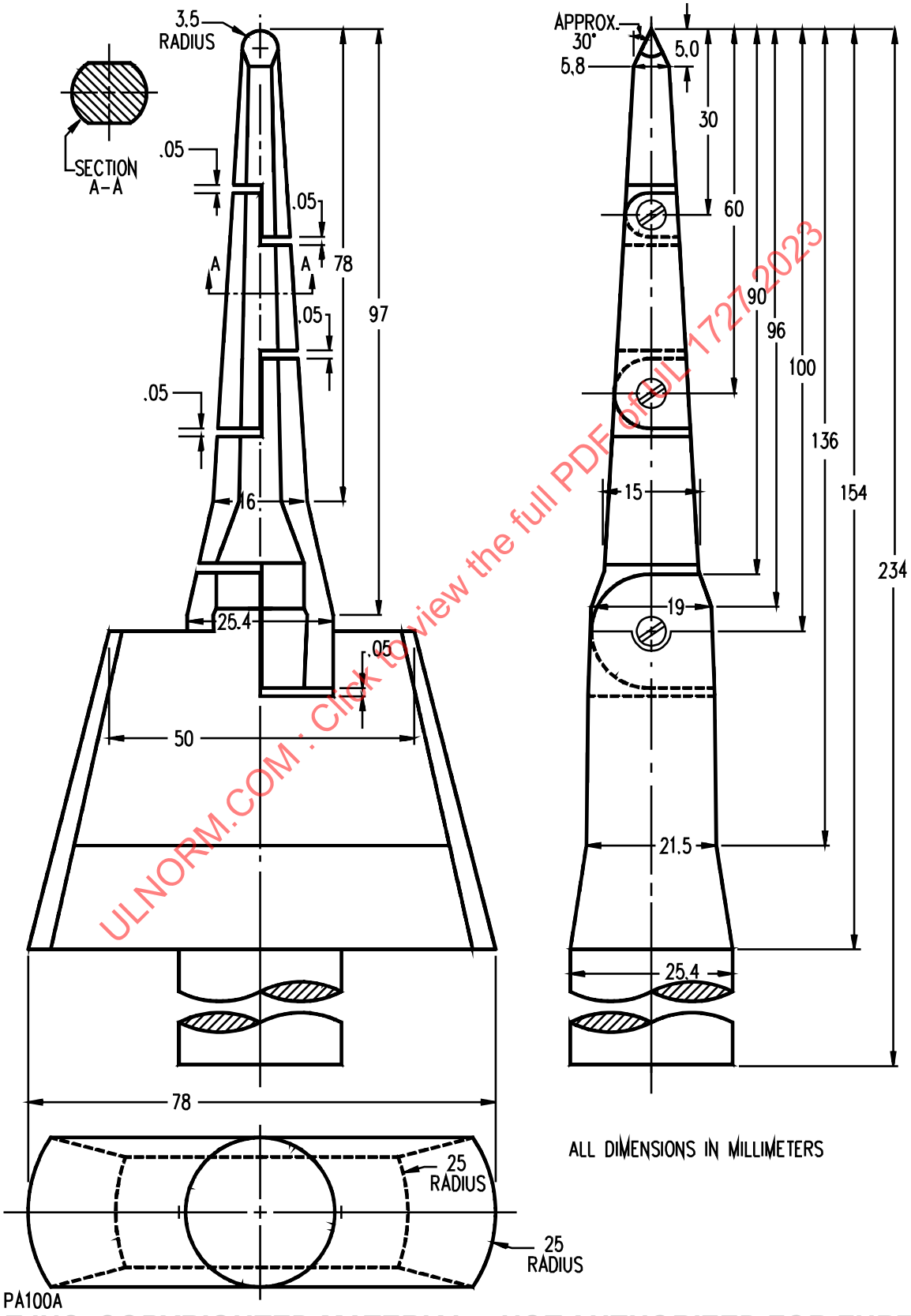

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Table 9.2
Minimum distance from an opening to a part that may involve a risk of electric shock or injury to persons

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.

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Figure 9.2

Probe for film-coated wire

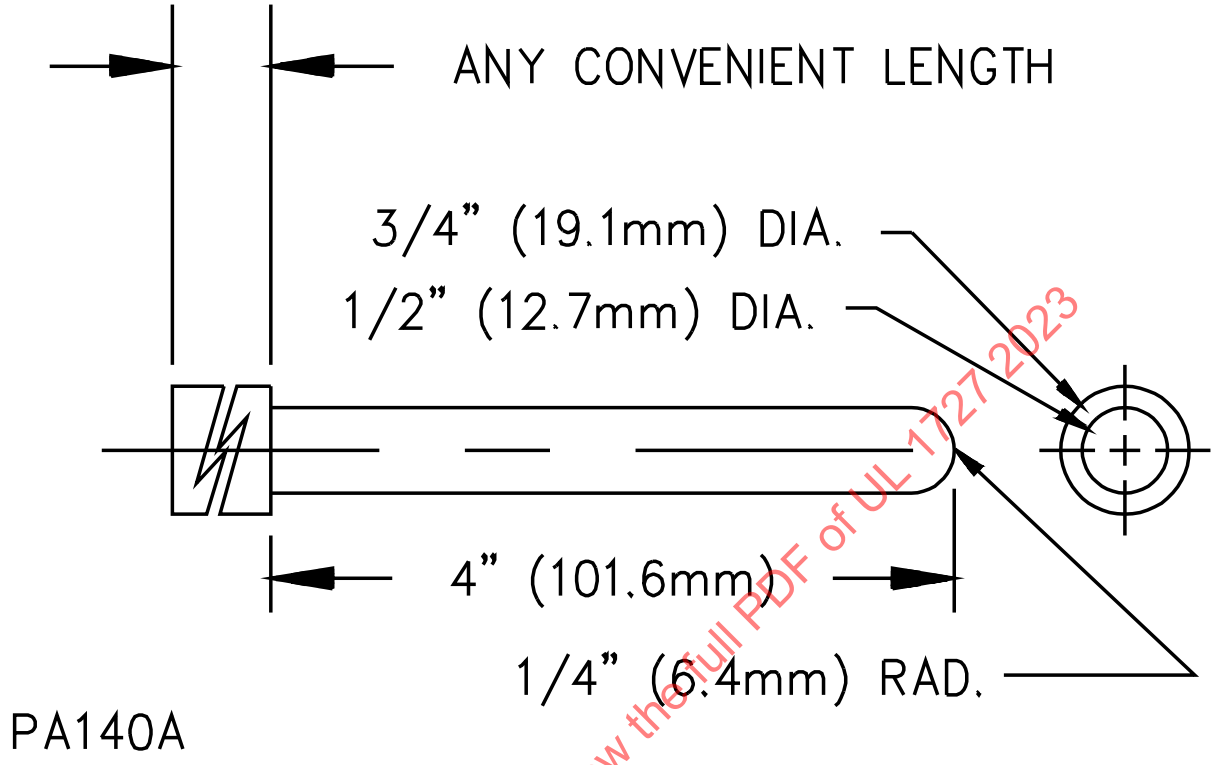

Figure 9.3

Articulated probe

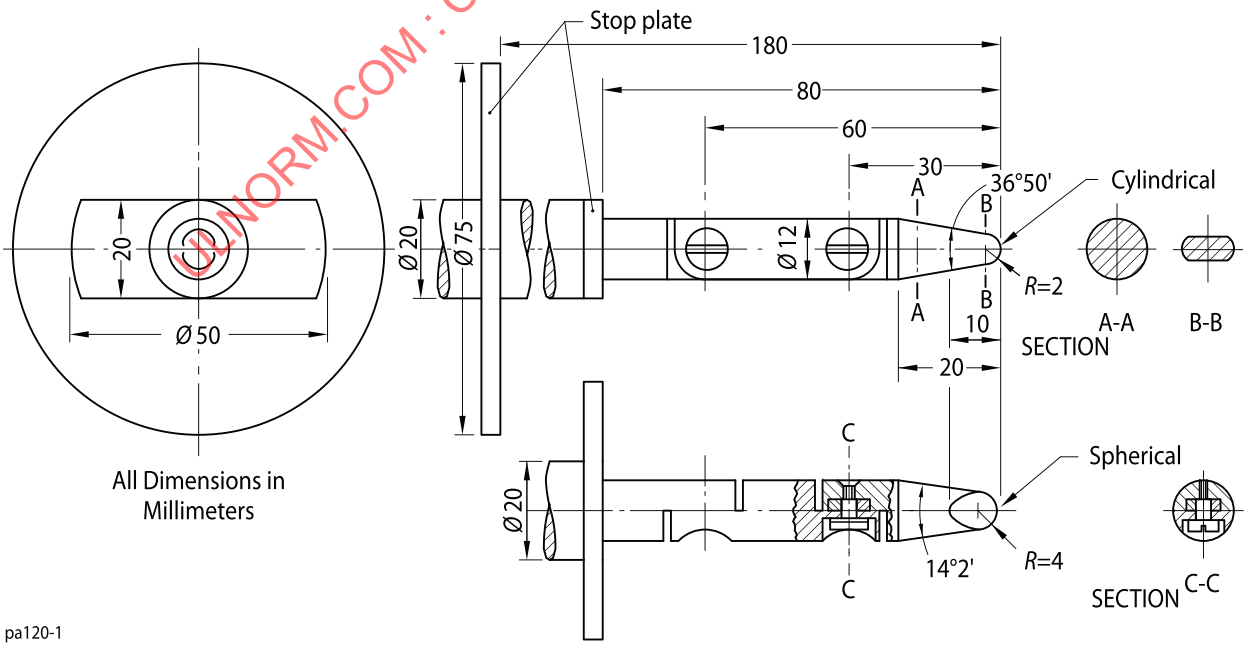

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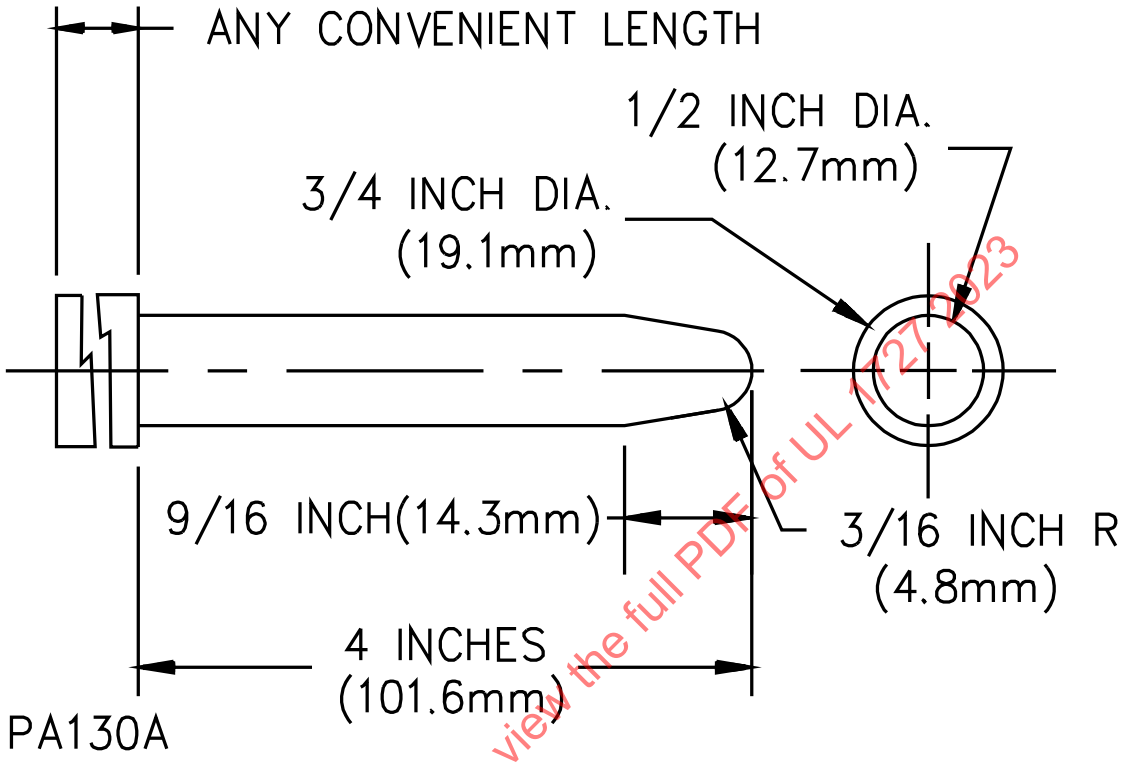
Figure 9.4

Probe for uninsulated live parts



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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.

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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.

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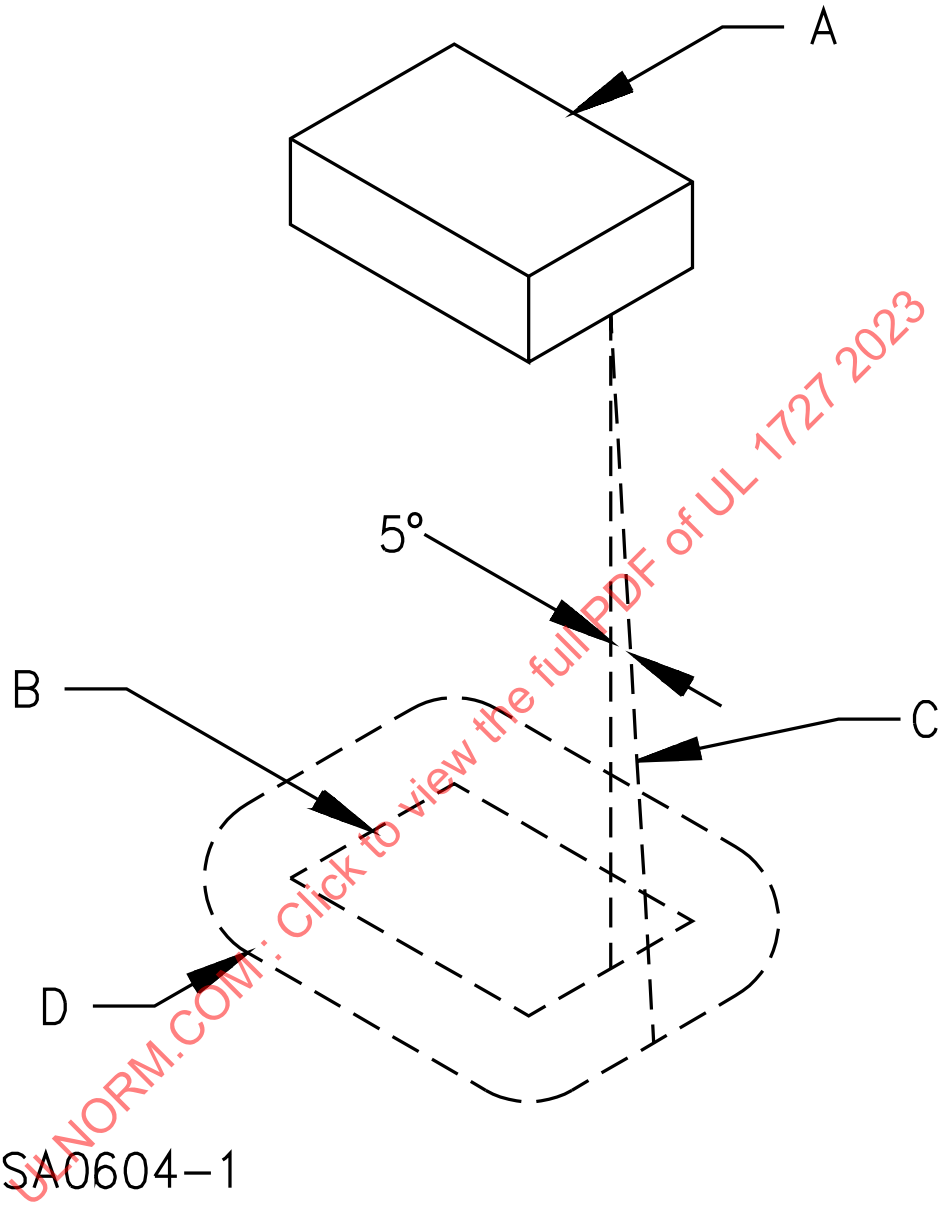
Figure 9.5

Location and extent of barrier



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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.

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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.

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9.7.3 When determining compliance with 9.7.2 any part of the enclosure or barriers that can be removed without the use of tools to gain access to the hanging means is to be removed.

9.7.4 A keyhole slot, notch, or hanger hole shall be located so that the supporting screws or the like cannot damage any electrical insulation or contact uninsulated current-carrying parts of the appliance.

9.7.5 A permanently installed wall-mounted appliance shall be provided with the necessary hardware for mounting in accordance with the installation instructions.

Exception: Small parts commonly available for the mounting of the appliance need not be provided if the installation instructions refer to such parts. See 82.4 for installation instructions.

10 Adhesives Used to Secure Parts

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

10.2 The requirement in 10.1 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.

11 Reduction of Risk of Injury to Persons

11.1 General

11.1.1 Materials employed in the construction of the appliance that are depended upon for reduction of the risk of injury to persons shall have such properties as to meet the demand of intended loading conditions.

11.1.2 Asbestos shall not be used in the airstream of an appliance in such form, manner, or location that it can be dissipated outside the appliance.

11.1.3 A moving part that can cause a risk of injury to persons shall be enclosed or provided with other means to reduce the risk of unintentional contact therewith.

Exception: A part or portion of a part that is necessarily exposed to perform the working function is not required to be enclosed but, when necessary, guarding shall be provided.

11.1.4 With reference to the requirement in 11.1.3 the general construction and intended use of the appliance are to be considered in investigating a guard or enclosure. Among the factors to be taken into consideration in evaluating the acceptability of an exposed moving part are the degree of exposure, the sharpness of the moving part, and the risk of fingers, arms, hair, or clothing being drawn into the moving part (such as at points where gears mesh, where belts travel onto a pulley, or where moving parts close in a pinching or shearing action).

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11.1.5 An appliance or any item furnished with the appliance shall have no sharp edge, burr, point, or spike inside or outside the appliance that may cause injury to persons during intended use and maintenance.

Exception: This requirement does not apply to a part or portion of a part needed to perform a working function.

11.1.6 Whenever referee measurements are necessary to determine that a part as mentioned in 11.1.5 is not sufficiently sharp to constitute a risk of injury to persons, the method described in the Standard for Tests for Sharpness of Edges on Equipment, UL 1439, is to be used.

11.1.7 A device that automatically starts an appliance, such as a timer, an automatically reset overload-protective device, or similar part, shall not be used unless it can be demonstrated that automatic starting will not result in a risk of injury to persons. See 79.6.1.

11.1.8 On an appliance adjustable for height, means shall be provided for holding the upper parts securely in position. Means shall also be provided to prevent the upper part from descending rapidly if the securing means, including a hydraulic or a pneumatic device, loosens or fails to operate as intended.

11.1.9 A hand-supported hair dryer shall have each air intake opening provided with a screen or equivalent means so that there are no openings larger than 0.004 square inch (2.58 mm^2).

11.2 Appliances with reservoirs

11.2.1 An appliance in which liquid reaches a temperature greater than 46°C (115°F) shall comply with 11.2.2 – 11.2.4, 54.2, and the Tip-over Test, Section 55.1. See Figure 55.1.

Exception: A wax-depilatory appliance is not required to comply with these requirements.

11.2.2 The construction of the appliance shall be such as to reduce the risk of injury under conditions simulating intended use. Openings through which liquid can be emitted shall not be provided unless such openings are required to perform an operating function.

11.2.3 An appliance with a vessel or container that has a capacity of more than 32 fluid ounces (946 ml) shall be provided with a fully inserting or a lock-on lid.

11.2.4 If any part of an appliance requires assembly (for example, engagement of a twist-lock part), then improper assembly that might result in a risk of injury to persons shall be clearly visible to the user.

11.3 Wax depilatory appliances

11.3.1 The maximum temperature of the wax, measured as described in 46.5.1 – 46.5.3, shall not exceed 75°C (167°F).

11.3.2 The maximum temperature of surfaces that may be contacted by the user shall be as specified in Table 46.2.

11.3.3 When there are multiple heat settings (for example, a setting for maintaining molten wax at the intended temperature for application to all of the skin and a higher heat setting for quick melting of solid wax), the appliance shall comply with all of the following:

a) If the wax is capable of being heated above 75°C (167°F) for quick melting, the reservoir in which the wax is so heated shall be provided with a nonremovable, self-closing lid or cover.

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b) A visible overheat condition indicator shall be provided. Such an indicator shall indicate when the wax temperature exceeds 75°C. This indicator shall be separate and independent of any other temperature indicator (for example, an indicator light whose functioning depends upon the setting of an adjustable thermostat) which may be provided. See 46.5.3, 81.9(l)(10), and 83.8(e).

c) A marking (such as a number or symbol) shall be provided adjacent to each heat selector position. A permanent marking shall be provided on the appliance in accordance with 79.14.1(b), and the Use and Care Instructions shall warn the user against applying wax that has been heated at a setting higher than the intended setting. See 81.9(l)(10).

d) A part of a temperature control that is user-operated (an adjustment knob or similar part) shall be constructed so that deliberate and positive action by the operator is required to select a heat setting or to change from one heat setting to another. A construction that requires two separate and distinct motions by the user (such as push and turn) is an example of a control that complies with this requirement.

11.3.4 With reference to 11.3.3(a), a nonremovable cover is one which requires special tools (tools not available to other than service personnel) for removal. A self-closing cover is a cover that returns to its fully closed position without any action on the part of the user other than releasing it from any opened position while the appliance is supported by a flat, horizontal surface.

11.3.5 In accordance with 50.3.19.5 and 83.8, if the malfunction of a temperature-regulating control increases the application temperature of the wax above 75°C (167°F), visible means, such as an indicator light, shall be provided to inform the user of an overheat condition.

Exception: A visible overheat condition indicator is not required if a thermal cutoff or a trip-free manual-reset thermostat operates upon short-circuiting of the temperature-regulating control. The temperatures attained by the wax, and surfaces of the appliance that are handled or contacted by the user during intended use, at the time the thermal cutoff or thermostat opens shall not present a risk of burn as determined by an appropriate investigation. The investigation shall include consideration of the length of time that temperatures remain above the specified limits, the thermal inertia of the materials involved, and similar factors.

12 Protection of Service Personnel

12.1 The requirements in this section apply only to appliances of such size and complexity that it may be necessary for service personnel to reach over, under, across, or around uninsulated electrical parts or moving parts to perform service functions while the unit is energized.

12.2 Uninsulated parts that involve a risk of electric shock shall be located or protected so that unintentional contact with the parts is not likely during service operations involving other parts of the unit.

12.3 Moving parts that can cause injury to persons and that must be in motion during service operations not involving the moving parts shall be located or protected so that unintentional contact with the moving parts is not likely.

12.4 If a guard must be removed during servicing of a part involving a risk of electric shock or injury to persons, the guard shall be constructed and arranged so that it can be removed and replaced with a minimum of effort.

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13 Mechanical Assembly

13.1 The assembly of an appliance that involves a motor or other vibrating unit shall be such that the appliance will not be affected adversely by the vibration of intended operation. Brush caps shall be tightly threaded or otherwise constructed to prevent loosening.

13.2 A switch (other than a through-cord switch), a lampholder, a receptacle, a motor-attachment plug, or similar component shall be mounted securely and shall be prevented from turning.

Exception No. 1: The requirement that a switch be prevented from turning can be waived if all the following conditions are met:

a) The switch is of the 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 of mounting the switch is such that the operation of the switch is unlikely to result in the switch becoming loosened;

c) The spacings are not reduced below the minimum acceptable values if the switch does rotate; and

d) 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 by a nonremovable jewel) need not be kept from turning if the rotation cannot reduce spacings below the minimum required values.

13.3 The means by which the turning mentioned in 13.2 is prevented shall include more than friction between surfaces. For example, a lock washer, properly applied, is acceptable as a means to prevent turning of a device having a single-hole mounting means.

13.4 Positive means shall be provided to keep parts of an appliance from turning with respect to each other if such turning would result in reduction of spacings, twisting of wires, and the like.

Exception: If such parts depend upon 3/8 inch (9.5 mm) or larger pipe threads, no additional means to prevent turning need be provided.

13.5 An appliance intended for connection to a supply of air, water, or the like shall have provisions for such connections. Field connections shall be possible without drilling, cutting, threading, or other alteration of the appliance. During the making of the field connections, internal wiring or electrical components shall not be subject to mechanical damage or stress.

13.6 An appliance that is shipped from the factory disassembled or unassembled to the degree necessary to facilitate shipment shall comply with all of the following:

a) All parts shall be furnished by the manufacturer;

b) Electrical continuity shall be maintained between field-assembled parts;

c) The appliance shall be such that the field assembly can be accomplished without drilling, cutting, threading, or any alteration other than for permanent connection to the supply source;

d) The assembly arrangement, location, and orientation of the separate parts shall be established at the time of manufacture and shall not be dependent on the installer.

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13.7 A fastener that secures the insulating tip of a curling iron, a heated brush, or a similar appliance shall be constructed, fastened, or located so as to prevent the fastener from becoming loosened if such loosening can result in a risk of fire or electric shock.

13.8 Compliance with the requirement in 13.7 may be accomplished by use of:

a) Staked and upset screws,

b) Screws with properly applied lock washers,

c) Press fitting of the insulating tip into place, or

d) Other equivalent means.

A polymeric material relied upon to prevent the fasteners from loosening shall have acceptable mechanical strength, resistance to heat, and dimensional stability. All of these properties are to be considered with respect to thermal aging.

13.9 If any part of a metal spring of a hair clamp of a curling iron or a similar appliance can become loose inside the enclosure of electrical parts as a result of breakage of the spring, the construction shall be such that electrical spacings will not be reduced.

13.10 Compliance with the requirement in 13.9 may be accomplished by:

a) Locating all parts of the spring outside the enclosure of electrical parts,

b) Using barriers,

c) Using physical restraints, or

d) Using other equivalent means.

14 Stability

14.1 A floor- or counter-supported appliance shall be constructed such that it will not be overturned when tested in accordance with 54.1.

Exception: An appliance whose overturning during intended use will not present a risk of burns or injury to persons is not required to be tested.

14.2 With reference to 14.1 a hand-supported hair dryer provided with a stand for conversion into a counter-supported hair dryer is to be considered a hand-supported appliance and is not to be subjected to the stability test.

14.3 A wax depilatory appliance shall be tested and the results shall be evaluated as described in 54.2, except that the wax may be in any combination of solid and liquid states anticipated during the intended operation of the appliance. Any movable parts or covers are to be in the positions that result in the most adverse conditions of use.

Exception: The test need not be conducted on a construction for which there is no possibility of molten wax spilling from its container under any condition of use, such as constructions in which the wax material is contained within completely enclosed wax applicators.

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15 Corrosion Resistance

15.1 Iron and steel parts shall be made corrosion resistant by painting, galvanizing, plating, or other equivalent means if the malfunction of such unprotected parts would be likely to result in a risk of fire, electric shock, or injury to persons.

Exception No. 1: In certain instances in which the oxidation of iron or steel due to the exposure of the metal to air and moisture is not likely to be appreciable, thickness of metal and temperature also being factors, surfaces of sheet steel and cast-iron parts within an enclosure may not be required to be made corrosion resistant.

Exception No. 2: Bearings, laminations, or minor parts of iron or steel, such as washers, screws, and the like need not be made corrosion resistant.

15.2 A container for liquid shall be made resistant to the possible corrosive effect of the liquid intended to be used in the container.

16 Supply Connections

16.1 Permanently-connected appliances

16.1.1 An appliance intended for permanent connection to a power supply, either by being fastened in place, located in a dedicated space, or both, shall have provision for connection of one of the wiring systems that would be acceptable for the appliance.

Exception: If an appliance is not intended for permanent connection to a power supply, and yet is intended to be either fastened in place, located in a dedicated space, or both, it may be provided with a short length of flexible cord in accordance with 16.4.1 – 16.4.12 and with an attachment plug for supply connection. The investigation of such a feature will include consideration of the utility of the appliance and the reasons for having it detachable from its supply source by means of the attachment plug.

16.1.2 A knockout in a sheet-metal enclosure provided for connection of the appliance to a wiring system installed in accordance with the National Electrical Code, ANSI/NFPA 70, shall be securely attached and shall be removable without deformation that would impair the intended performance of the enclosure.

16.1.3 The diameter of a knockout shall be adequate to accommodate conduit of the trade size for which the knockout is intended as specified in Table 16.1.

16.1.4 There shall be a flat surface surrounding a knockout of sufficient area to accommodate attachment of a rigid metallic conduit of a size corresponding to the size of the knockout. The flat area shall have a minimum diameter in accordance with Table 16.1.

Table 16.1
Dimensions associated with knockouts for conduit

Trade size of conduit,		Unthreaded openings			
		Nominal knockout diameter,		Minimum diameter of flat surface at knockout,	
inch	(mm)	inches	(mm)	inches	(mm)
1/2	(12.7)	7/8	(22.2)	1.152	(29.26)
3/4	(19.1)	1-3/32	(27.8)	1.450	(36.83)
1	(25.4)	1-23/64	(34.5)	1.804	(45.82)

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16.2 Field-wiring compartments

16.2.1 A field-wiring compartment in which power supply connections are to be made shall be located so that, during the making of electrical connections, the internal wiring and electrical components will not be exposed to mechanical abuse or stress; and, after the appliance has been installed as intended, such connections will be readily accessible for inspection.

16.2.2 Accessibility of field-installed wiring and inspection of splices is to be judged by:

a) Conducting a trial installation following any instructions provided by the manufacturer or

b) Using any wiring system permitted by the National Electrical Code, ANSI/NFPA 70, if no instructions are provided.

16.2.3 The minimum usable volume of an outlet box or terminal compartment in which field-installed wiring connections to the power supply are to be made shall be as specified in Table 16.2.

Exception: A motor containing an integral wiring compartment that complies with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, is not required to comply with this requirement.

Table 16.2
Minimum usable volume of terminal compartment

Size of field-installed conductors, AWG	(mm^2)	Volume for each field-installed wire originating outside of the compartment and terminating inside the compartment,[a] cubic inches	(cm^3)
14	(2.1)	2.00	(33)
12	(3.3)	2.25	(37)
10	(5.3)	2.50	(41)
8	(8.4)	3.00	(50)
6	(13.3)	5.00	(82)

[a] Including a grounding conductor.

16.2.4 There shall be sufficient space within the enclosure for the installation of wires and cables likely to be used when connecting the supply circuit to the equipment.

16.2.5 In the investigation of wiring spaces, it is assumed that the size, type, and conductor material of a wire to be used for installation of wiring connection shall be in accordance with the National Electrical Code, ANSI/NFPA 70.

16.2.6 Wire-bending space when the conductor does not enter or leave the enclosure through the wall opposite its terminal shall be as specified in Table 16.3.

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Table 16.3
Minimum wire-bending space, inches

Wire size, AWG	Wires per terminal (pole)	
	1	2
14 – 10	Not specified	Not specified
8 – 6	1-1/2 inches	–

NOTES

1 For SI units: 1 inch = 25.4 millimeters.

2 Wire-bending space at terminals shall be measured in a straight line from the center of the wire opening, in the direction the wire leaves the terminal, to the wall, barrier or obstruction. (For instructions on measuring, see 16.2.9.)

3 The minimum wire-bending space required for wire sizes or combinations of wires not covered will be determined by investigation.

16.2.7 Wire-bending space when the conductor enters or leaves the enclosure through the wall opposite its terminal shall be as specified in Table 16.4.

Table 16.4
Minimum wire-bending space, inches

Wire size, AWG	Wires per terminal (pole)	
	1	2
14– 10	Not specified	Not specified
8	1-1/2 inches	–
6	2 inches	–

NOTES

1 For SI units: 1 inch = 25.4 millimeters.

2 Wire-bending space at terminals shall be measured in a straight line from the edge of the terminal closest to the wall, in a direction perpendicular to the enclosure wall. (For instructions on measuring, see 16.2.9.)

3 The minimum wire-bending space required for wire sizes or combinations of wires not covered will be determined by investigation.

16.2.8 If a conductor is restricted by a barrier or other means from being bent where it leaves the connector, the distance is to be measured from the end of the barrier.

16.2.9 For a wire-bending space measurement, the lug or connector is to be at the smallest angle to the perpendicular to the box wall that it can assume without defeating any means provided to prevent its turning (such as a boss, shoulder, walls of a recess, multiple bolts securing the connector, and the like). However, it is assumed that the connector is not so oriented that the wire will be directed into a corner of the box to such extent that the transverse wall would necessitate additional bending. If the terminal is provided with one or more lugs or connectors for the connection of conductors in multiple, the distance is to be measured from the wire opening closest to the wall of the enclosure. If the connectors for a circuit are fixed in position (for example, by the wall of a recess) so that they are turned toward each other, the distance is to be measured at the wire opening nearest to the wall in a direction perpendicular to the wall. A barrier, shoulder, or the like is to be disregarded when the measurement is being made if it does not reduce the radius to which the wire must be bent otherwise.

16.2.10 A wiring space in which knockouts are provided shall be of such a width as to accommodate (with respect to bending) conductors of the maximum size likely to be used at that knockout.

Exception: The wiring space may be of lesser width when:

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a) Knockouts of required size are provided elsewhere in the equipment;

b) The wiring space at such other point or points is sufficiently wide to accommodate the conductors in question; and

c) The knockout or knockouts at such other points can be conveniently used in the intended wiring of the appliance.

The values of the minimum acceptable width of a wiring space, with respect to conductors entering the knockout, are the same as the values of minimum bending space given in Table 16.3.

16.2.11 An electrical component shall not be mounted on a part, such as the cover of a wiring-terminal compartment, that must be moved so that field-wiring connections can be made or inspected.

16.2.12 A field-wiring compartment intended for connection of a supply raceway and mounted integrally with the appliance shall be attached so as to be kept from turning with respect to the appliance.

16.2.13 If the constructional features of an appliance are such that field-wiring connections can be made in the motor terminal compartment, the compartment shall comply with the applicable requirements for electric motors.

16.3 Wiring terminals and leads

16.3.1 An appliance intended for permanent connection to the power supply shall be provided with wiring terminals, including an equipment grounding terminal, for the connection of conductors having an ampacity acceptable for the appliance; or the appliance shall be provided with leads acceptable for such connection.

16.3.2 A wiring terminal shall be provided with a soldering lug or with a pressure terminal connector securely fastened in place (for example, firmly bolted or held by a screw).

Exception: A wire-binding screw may be used at a wiring terminal intended to accommodate a 10 AWG (5.3 mm^2) or smaller conductor if upturned lugs or a cupped washer or the equivalent are provided to hold the wire in position.

16.3.3 Upturned lugs or a cupped washer or the equivalent shall be capable of retaining the conductor mentioned in 16.3.1 under the head of the screw or the washer.

16.3.4 A wiring terminal shall be prevented from turning or shifting in position by means other than friction between surfaces. This may be accomplished by two screws or rivets; by square shoulders or mortices; by a dowel pin, lug or offset; by a connecting strap or clip fitted into an adjacent part; or by an equivalent means.

16.3.5 A wire-binding screw at a wiring terminal shall not be smaller than No. 10 (4.8 mm).

Exception: A No. 8 (4.2 mm) screw may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm^2) conductor, and a No. 6 (3.5 mm) screw may be used for the connection of a 16 AWG (1.3 mm^2) or 18 AWG (0.82 mm^2) control-circuit conductor.

16.3.6 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050 inch (1.27 mm) thick. There shall be two or more full threads in the metal, which may be extruded if necessary to provide the threads.

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Exception: A plate less than 0.050 inch thick, but not less than 0.030 inch (0.762 mm) thick, may be used if the tapped threads are determined to have equivalent mechanical strength.

16.3.7 A wire-binding screw shall thread into metal.

16.3.8 An appliance intended for connection to a grounded power supply conductor and employing:

a) A lampholder of the Edison screw-shell type;

b) A single-pole switch; or

c) A single-pole, automatic control

shall have one terminal or lead intended for connection of the grounded conductor of the supply circuit. The terminal or lead intended for grounded connection shall be the one that is connected to the screw shell of a lampholder and shall have no connection to a single pole switch or single pole automatic control.

Exception: With respect to connection of a single pole automatic control, the requirements in 32.1 shall apply.

16.3.9 With reference to 16.3.8, if leads from a motor or other component terminate in an attachment plug intended for insertion in a receptacle that is:

a) Provided as part of the appliance and

b) Intended for connection of the branch-circuit power supply conductors,

the plug and receptacle shall be polarized if a single-pole switch or an Edison-base lampholder is connected in the load side of these devices.

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

16.3.11 A lead intended for field connection shall comply with the following:

a) The lead shall be not smaller than 18 AWG (0.82 mm^2);

b) The insulation thickness shall comply with Table 16.5; and

c) The free length of the lead inside an outlet box or wiring compartment shall be at least 6 inches (152 mm).

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Table 16.5
Characteristics of leads intended for field connection

Insulation	Nominal wall thickness of insulation,		Braid or jacket required	Nominal thickness of braid or jacket,	
	inch	(mm)		inch	(mm)
Thermoplastic or neoprene	1/32[a]	(0.8)	No[a]	–	–
Rubber	1/32[b]	(0.8)	Yes[a]	1/64[a]	(0.4)
Cross-linked synthetic polymer[c]	1/64	(0.4)	No	–	–

[a] The nominal wall thickness may be less than 1/32 inch but not less than 1/64 inch if the wire is provided with a braid or jacket having a nominal thickness not less than 1/64 inch.

[b] For heat-resistant rubber other than of a silicone type, the nominal wall thickness is to be not less than 3/64 inch (1.2 mm) and no braid is required.

[c] Synthetic compounds other than neoprene or rubber, such as that used on Type XHHW wire.

16.3.12 The exterior surface of a lead intended for field connection shall be white or grey, and that lead shall be readily distinguishable from other leads.

16.3.13 The exterior surface of an insulated lead intended solely for the connection of an equipment-grounding conductor shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

16.3.14 A wire-binding screw intended for the connection of an equipment grounding conductor shall have a green-colored head that is hexagonal, or slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified by the marking "G," "GR," "GND," "Grounding," or the like on or adjacent to the terminal or by a marking on the wiring diagram provided on the appliance. The wire-binding screw or pressure wire connector shall be so located that it is unlikely to be removed during servicing of the appliance.

16.4 Cord-connected appliances

16.4.1 An appliance intended for cord connection shall be provided with a length of flexible cord and an attachment plug for connection to the supply circuit. A coiled cord may be used in a hand-supported or wall-hung appliance. A coiled cord may also be used in a floor- or counter-supported appliance if such usage will not result in a condition (for example, the appliance being pulled off a table by the force of the cord) likely to present a risk of burn, electric shock, fire, or injury to persons. The cord length is to be measured from the point of cord entry into the enclosure, or into the wiring device at the attachment plug and shall be within the limits specified in Table 16.6.

16.4.2 If a coiled cord is used, the cord length shall comply with Table 16.6 when the cord is in the uncoiled position.

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Table 16.6
Cord lengths for specific conditions

Type of appliance	Cord length			
	Minimum,		Maximum,	
	feet	(m)	feet	(m)
Appliance supported by table or counter top	5	(1.52)	8	(2.44)
Wall-hung appliance with attached appliance supported by hand	10[a]	(3.05)	12[a]	(3.66)
	2[b]	(0.61)	3[b]	(0.91)
Appliance usually supported by hand	9	(2.74)	12	(3.66)
Hair dryer, floor-supported	3[c]	(0.91)	9	(2.74)
All appliances not covered above	6	(1.83)	8	(2.44)

[a] Between wall unit and hand unit.

[b] Between wall unit and receptacle.

[c] If the cord entry point is higher than 2 feet (0.61 m) above the floor, one additional foot (0.3 m) is to be added to the minimum cord length for each additional foot that the cord entry point is located above the floor, or fraction thereof, up to a maximum cord length of 6 feet (1.83 m).

16.4.3 The flexible cord may be permanently attached to the appliance; or, for other than a hand-supported appliance, in the form of a detachable power supply cord with means for connection to the appliance. Examples of the means for connection are:

a) An appliance plug;

b) A flatiron plug; or

c) A cord connector cooperating with pin or blade terminals on the appliance.

16.4.4 A cord set, detatchable power supply cord, and power supply cord with or without integral fittings, shall comply with the requirements in the Standard for Cord Sets and Power Supply Cords, UL 817.

Exception: A power supply with integral swivel assembly complies with the applicable requirements in this standard and the following requirements in UL 817:

a) Normal Temperature Test, Section 87, with the temperature rise at swivel contact not more than 30°C;

b) Dielectric Voltage Withstand Test, Section 88, with dielectric voltage applied:

1) Between two individual conductors of swivel plug and

2) Between conductors of swivel plug and metal foil tightly wrapped onto surface of molded-on swivel plug (other than fitting face);

c) Insulation Resistance Test, Section 89; and

d) Accelerated Aging Tests, Section 90.

16.4.5 The ampacity of the cord and of the plug shall be not less than the current rating of the appliance. Such components shall be rated for use at a voltage equal to the rated voltage of the appliance.

16.4.6 With respect to 16.4.5, the voltage rating of a dual voltage appliance is considered to be that for which the appliance is set when it is shipped from the factory.

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16.4.7 The flexible cord shall be of a type indicated in Table 16.7 or the equivalent.

Table 16.7
Acceptable types of cords and limitations on their use

Appliance on which cord is to be used	Cords acceptable where temperatures higher than 121°C (250°F) are attained on any surface the cord can touch	Cords acceptable where 121°C (250°F) or lower temperatures are attained on any surface the cord can touch
Floor supported	HSJ, HSJO, HS, HSO	HSJ, HSJO, HS, HSO, SJ, SJE, SJO, SJT, SJTO, S, SE, SO, ST, STO
Hand-supported hair dryers, heated-air curling irons and brushes, and counter-supported appliances	HPD, HPN, HSJ, HSJO	HPD, HPN, HSJ, HSJO, SP-2, SPE-2, SPT-2, SV, SVE, SVO, SVT, SVTO, SJ, SJE, SJO, SJT, SJTO
Facial saunas	–	SP-2, SPE-2, SPT-2
Combs	SP-2, SPE-2, SPT-2, HPN	SP-2, SPE-2, SPT-2, HPN
Curling irons and brushes, hair-crimping and hair-straightening irons, and similar hand-supported appliances	TPT[a], SP-1, SPE-1, SPT-1, XT[b], HPD, HPN	TPT[a], SP-1, SP-2, SPE-1, SPE-2, SPT-1, SPT-2, XT[b], HPD, HPN
Manicure and pedicure sets	–	SP-2, SPE-2, SPT-2

[a] Type TPT cord may be used with appliances rated 50 watts or less and weighing 1/2 pound (454 g) or less. The weight is to be determined without the power supply cord.

[b] Minimum 20 AWG (0.52 mm^2) parallel, 2-conductor construction required.

16.4.8 The attachment plug of a cord-connected appliance and the integral blades of a direct plug-in appliance provided with a 15- or 20-ampere, general-use receptacle shall be of the 3-wire grounding type. The attachment plug and the integral blades of all other cord-connected and direct plug-in appliances provided with either a line-connected, single-pole on-off switch or overcurrent protective device, or an Edison-base lampholder shall be polarized or of the grounding type.

16.4.9 A power supply cord with integral fittings shall comply with the requirements in the Standard for Cord Sets and Power Supply Cords, UL 817, except that it is not required to be provided with integral overcurrent protection.

16.4.10 Attachment plugs, appliance couplers, appliance inlets (motor attachment plugs), and appliance (flatiron) plugs, shall comply with the Standard for Attachment Plugs and Receptacles, UL 498. See 20.3.15 for single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment.

Exception No. 1: Attachment plugs and appliance couplers integral to cord sets or power supply cords that are investigated in accordance with the Standard for Cord Sets and Power Supply Cords, UL 817 are not required to comply with UL 498.

Exception No. 2: A fabricated pin terminal assembly need not comply with UL 498 if it complies with:

a) Mechanical Assembly, Section 13;

b) Accessibility of live parts; Section 9.4;

c) Live Parts, Section 17;

d) Pin terminals, Section 16.5;

e) Electrical Insulation, Section 23; and

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f) Spacings, Section 34

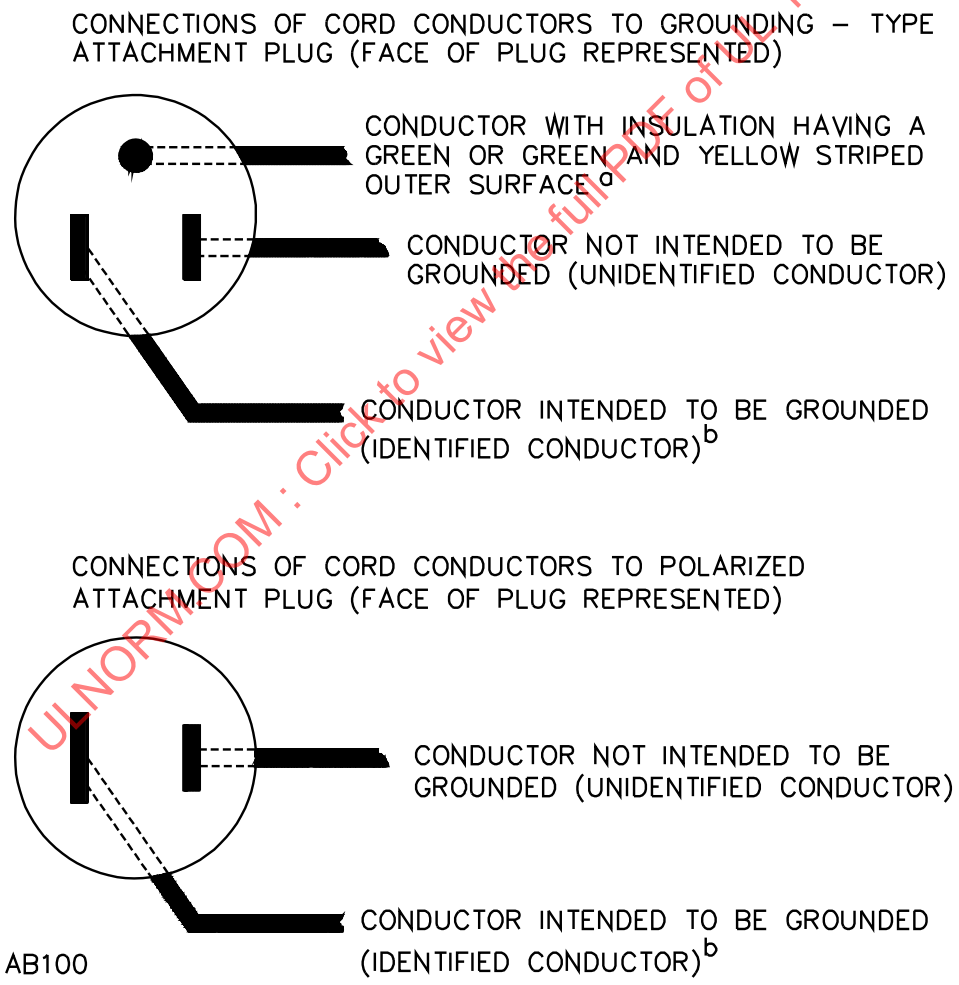
of this standard.

16.4.11 Female devices (such as appliance couplers, and connectors) that are intended, or that may be used, to interrupt current in the end product, shall be suitably rated for current interruption of the specific type of load, when evaluated with its mating plug or connector. For example, an appliance coupler that can be used to interrupt the current of a motor load shall have a suitable horsepower rating when tested with its mating plug.

16.4.12 Connections of the flexible cord conductors to a 2- or 3-wire polarized attachment plug shall be as illustrated in Figure 16.1.The polarity identification of the flexible cord shall comply with Table 16.8.

Figure 16.1

Connection to attachment plug



[a] In the above illustration, the blade to which the green conductor is connected may have a U-shaped or circular cross section.

[b] Signifies a conductor identified in accordance with Table 16.8.

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Table 16.8
Polarity identification of flexible cords

Method of polarity identification	Combinations	
Wire intended to be grounded[a]	All other wires[a]	
Colored braid	Solid white or gray	Solid color other than white or gray
Tracer in braid	Solid white or gray braid with no tracer in braid[b]	Solid white or gray braid with a colored tracer in braid[b]
Tracer in braid	Colored tracer in braid of a color other than white or gray	No tracer in braid of solid color other than white or gray
Colored insulation[c]	Solid white or gray	Solid color other than white or gray
Colored insulation[c]	Light blue[d]	Solid color other than light blue, white, or gray[d]
Colored separator[e]	White or gray	Color other than white or gray
Tinned conductors[f]	Tin or other white metal on all strands of the conductor	No tin or other white metal on the strands of the conductor
Surface marking[e]	One or more stripes, ridges, or grooves, or a combination of these on the exterior surface of the cord	–

[a] A conductor having insulation finished to show a green color with or without one or more straight or helical unbroken yellow stripes or having a green braid with or without one or more yellow tracers is to be used only as an equipment grounding conductor. See also 38.1.4 for the description of an equipment grounding conductor and Figure 16.1 for the connection of conductors to attachment plugs.

[b] Only for Types C and PD cords.

[c] Only for a cord having no braid on any individual conductor.

[d] Only for a cord having a jacket that is not integral with the circuit conductor insulation.

[e] Only for Types SP-1, SP-2, SPE-1, SPE-2, SPT-1, and SPT-2 cords.

[f] Only for Types SPT-1 and SPT-2 cords.

16.4.13 A cord reel shall comply with "special use cord reel" requirements of the Standard for Cord Reels, UL 355. For products provided with cord tag, the cord tag shall not retract into cord reel.

16.5 Pin terminals

16.5.1 If an appliance is provided with pin terminals, the construction of the appliance shall be such that no live part will be exposed to unintentional contact both during or after the placement of the plug on the pins in the intended manner.

16.5.2 If an appliance is provided with pin terminals, a pin guard is required such that:

a) A straight edge placed in any position, across and in contact with edges of the plug opening without the plug in place, cannot be made to contact any current-carrying pin.

b) With the plug aligned with the pins and the face of the plug in a plane located perpendicular to the end or ends of the farthest projecting current-carrying pin, the probe illustrated in Figure 9.1 shall not touch any current-carrying pin while the probe is inserted through any opening with the appliance in any position.

16.5.3 If the pins on the appliance are of American National Standard configuration, the plug used in 16.5.2(b) shall consist of an appliance plug in accordance with the Standard for Wiring Devices – Dimensional Specifications, ANSI/NEMA WD6-1997.

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16.5.4 If the pins on the appliance are not of an American National Standard configuration, the plug used in 16.5.2(b) is to be the plug supplied with the appliance, 125 volts, 10 amperes, and 250 volts, 5 amperes.

16.5.5 If an appliance employs three or more pin terminals intended for use with a plug that covers all the pins, the terminals shall be so spaced that they will not mate with a cord connector for which the pins are not intended, such as a flatiron plug or an appliance plug. The plug these pins will accommodate shall be that required for the particular application.

16.5.6 A pin terminal shall be securely and rigidly mounted and shall be prevented from shifting in position by means other than friction between surfaces.

16.5.7 The requirement in 16.5.6 is intended primarily to provide for the maintenance of spacings as given in 34.2 and to provide for the maintenance of required spacings between pin terminals. Under this requirement, consideration is also to be given to the means for locking terminals in position to maintain tightness.

16.5.8 The material on which the pin terminals are mounted, the proximity of any vapor outlet to the terminals, and the direction of the vapor spray shall be such that water will be prevented from accumulating at the terminals.

16.6 Strain relief

16.6.1 Strain relief shall be provided in accordance with the Strain Relief Test, Section 58, such that stress on a flexible cord will not be transmitted to a terminal, splice, or internal wiring in the appliance or in a fitting.

16.6.2 Insulating bushings serving as strain relief shall comply with the Standard for Insulating Bushings, UL 635. Tests specified in this standard (e.g. Strain Relief Test, Section 58) may still need to be performed to confirm the combination of the insulating bushing and the supporting part are suitable.

16.6.3 Strain relief shall be provided in accordance with the Torque Test, Section 59, such that stress on a flexible cord will not be transmitted to a terminal, splice, or internal wiring in the appliance or in a fitting.

16.6.4 A metal strain-relief clamp or band may be used with Type SP-2, SPE-2, or lighter general-use rubber-insulated cord only if acceptable auxiliary insulation is provided over the cord for mechanical protection.

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

16.6.5 A strain relief clamp of any material, metal or otherwise, is not acceptable for use on Type SPT-1, SPT-2, SVT, SVTO, or SVTOO cord.

Exception: A clamp may be used if the cord is protected by varnished-cloth tubing or by means that have been determined to be the equivalent under the clamp, and the construction complies with the requirements specified in 58.3.

16.6.6 For thermoplastic-insulated cord heavier than Types SVT, SVTO, and SVTOO, a clamp may be used, and auxiliary insulation is not required unless it is judged that the clamp is damaging to the cord insulation.

16.6.7 Means shall be provided to prevent the flexible cord from being pushed into the appliance enclosure through the cord-entry hole if such displacement might subject the cord to mechanical damage or to exposure to a temperature higher than that for which the cord is rated, or might reduce spacings

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(such as to a metal strain-relief clamp) below the minimum required values. Such means shall comply with the Power-Supply Cord Push-Back Relief Test, Section 60.

16.6.8 If a knot in a flexible cord serves as strain relief, the surface against which the knot may bear or with which it may come in contact shall be free of any projection, sharp edge, burr, fin, or the like that may cause abrasion of the insulation on the conductors.

16.7 Bushings

16.7.1 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 is substantial, reliably secured in place, and that has a smooth, rounded surface against which the cord can bear. 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 used;

b) The wall or barrier is of metal; and

c) The construction is such that the cord might be subjected to strain or motion.

The heat- and moisture-resistant properties of the bushing material shall be acceptable for the particular application.

16.7.2 If the cord hole is in wood, porcelain, phenolic composition, or other nonconducting material, a smooth, rounded surface is considered equivalent to a bushing.

16.7.3 Ceramic materials and some molded compositions are acceptable generally for insulating bushings. Vulcanized fiber may be employed if the bushing is no less than 3/64 inch (1.2 mm) thick, and if it is so formed and secured in place that it will not be affected adversely by conditions of ordinary moisture.

16.7.4 A separate soft rubber, neoprene, or polyvinyl chloride bushing may be used in the frame of a motor or in the enclosure of a capacitor physically attached to a motor (but not elsewhere in an appliance) provided that:

a) The bushing is not less than 3/64 inch (1.2 mm) thick and

b) The bushing is located so that it will not be exposed to oil, grease, oily vapor, or other substance having a harmful effect on the bushing material.

Exception: A bushing of any of the materials mentioned 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 and if the edges of the hole in which the bushing is mounted are smooth and free from any burr, fin, or the like.

16.7.5 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 inch (1.6 mm) thick at the point where the cord passes through the enclosure.

16.7.6 Insulating bushings shall comply with the Standard for Insulating Bushings, UL 635.

16.8 Direct plug-in appliances

16.8.1 With respect to Figure 16.2, the maximum acceptable moment, center of gravity, dimensions, and weight of a direct plug-in appliance shall comply with the requirements specified in (a) – (d). See 16.8.2 and 16.8.3 for symbol definitions and methods of application.

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a) The quotient of WY/Z shall not exceed 48 ounces (1.36 kg).

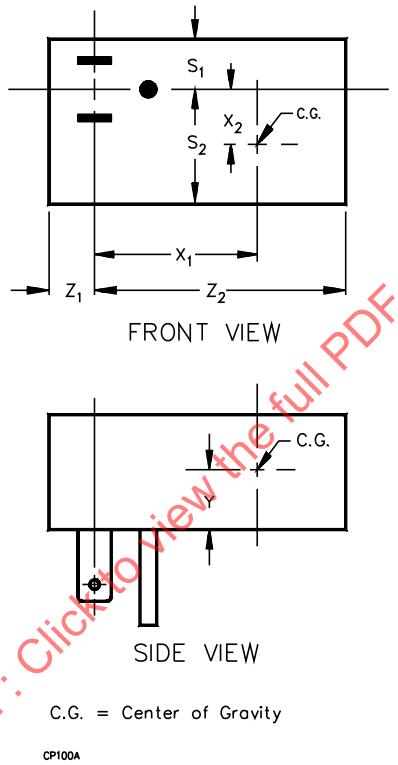
b) The quotient of WY/S shall not exceed 48 ounces.

c) The product of WX shall not exceed 80 ounce-inches (0.56 N·m).

d) The weight of an appliance shall not exceed 28 ounces (0.79 kg).

Figure 16.2

Dimensions of a direct plug-in appliance



16.8.2 Definitions for the symbols used in 16.8.1 are as follows:

W is the weight of the appliance;

Y is the distance illustrated in Figure 16.2;

Z is the shorter distance, Z1 or Z2, as illustrated in Figure 16.2;

S is the shorter distance, S1 or S2, as illustrated in Figure 16.2; and

X is the longer distance, X1 or X2, as illustrated in Figure 16.2.

16.8.3 The moment and weight specified in 16.8.1 are to be determined as follows:

a) For an appliance with an attached cord, the cord is to be cut off at the enclosure or at the strain-relief means if the strain-relief means extends outside the enclosure.

b) For an appliance with a directly mounted accessory, the values are to be measured with the accessory in place.

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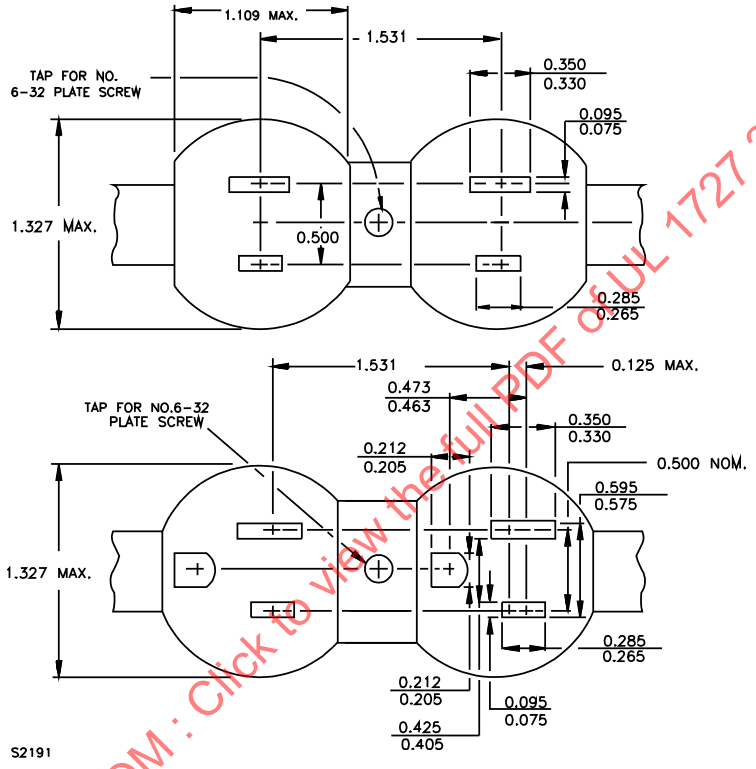
16.8.4 When inserted in a parallel-blade duplex receptacle, any part of an appliance shall not interfere with full insertion of an attachment plug into the adjacent receptacle. See Figure 16.3 for an illustration of the duplex receptacle.

Exception: An appliance that renders the adjacent receptacle completely unusable, is acceptable.

Figure 16.3

Parallel receptacle duplex



16.8.5 The enclosure of a direct plug-in appliance shall have a surface that facilitates gripping between the thumb and forefinger or some equivalent finger gripping means to provide for easy insertion and withdrawal from a receptacle outlet.

16.8.6 For the enclosure of a direct plug-in appliance, the perimeter of the face section from which the blades project shall be not less than 5/16 inch (7.9 mm) from any point on either blade.

17 Live Parts

17.1 A current-carrying part shall be of silver, copper, a copper alloy, or equivalent material.

17.2 Plated iron or steel may be used for a current-carrying part:

a) Whose temperature during intended operation is more than 100°C (212°F);

b) Within a motor or associated governor; or

c) If in accordance with General, Section 2,

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but unplated iron or steel may not be used. Stainless steel and other corrosion-resistant alloys may be used for current-carrying parts regardless of temperature.

17.3 An uninsulated live part shall be secured to the base or mounting surface so that it will be prevented from turning or shifting in position if such motion might result in a reduction of spacings below the minimum required values.

17.4 Friction between surfaces is not acceptable as a means to prevent shifting or turning of an uninsulated live part, but a lock washer, properly applied, is acceptable.

18 Wetting of Live Parts

18.1 There shall be no wetting of electrical parts that could increase the risk of fire, electric shock, or injury to persons as a result of any likely condition of normal or abnormal use, such as overfilling (see the Overflow Test, Section 53), improper replacement of parts that are moved or removed during user servicing, malfunction of liquid-handling systems (see the Flooding of Live Parts Test, Section 52), and moving of portable appliances.

18.2 No electrical part in an appliance having a reservoir arranged for hand filling by the user shall be wetted during any likely filling operation.

18.3 An appliance having a reservoir intended for filling by an automatic valve shall not result in electrical parts being wetted when the valve is held in its open position.

19 Liquid-Containing Parts

19.1 If the deterioration or breakage of any part that contains, conducts, or otherwise contacts a liquid can result in a risk of fire, electric shock, or injury to persons, the part shall be resistant to deterioration by the liquid under all conditions of use. The part shall also comply with the Physical Properties of a Liquid Container, Seal, or Diaphragm Test, Section 71.

20 Internal Wiring

20.1 General

20.1.1 Unless it is to be judged as an uninsulated live part, insulated internal wiring of an appliance (including a grounding conductor) shall consist of wire of a type or types that are acceptable for the particular application when considered with respect to:

a) The temperature and voltage to which the wiring is likely to be subjected;

b) Exposure to oil, grease, or other substances likely to have a harmful effect on the insulation;

c) Exposure to moisture; and

d) Other conditions of service to which it is likely to be subjected.

20.1.2 A separate foot switch provided with an appliance shall be connected to the appliance by flexible cord no lighter than Type SJ.

20.1.3 Internal wiring composed of insulated conductors shall comply with the Standard for Appliance Wiring Material, UL 758.

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Exception No. 1: Insulated conductors need not comply with UL 758 if they comply with one of the following:

a) The Standard for Thermoset-Insulated Wires and Cables, UL 44;

b) The Standard for Thermoplastic-Insulated Wires and Cables, UL 83;

c) The applicable UL standard(s) for other insulated conductor types specified in Chapter 3, Wiring Methods and Materials, of the National Electrical Code, ANSI/NFPA 70.

Exception No. 2: Insulated conductors for specialty applications (e.g. data processing or communications) and located in a low-voltage circuit not involving the risk of fire, electric shock or injury to persons need not comply with UL 758.

20.2 Protection of wiring

20.2.1 The wiring and connections between parts of an appliance shall be protected or enclosed. See 20.4.1 – 20.4.4 for requirements for interconnecting cords and cables.

20.2.2 With reference to exposure of insulated wiring through an opening in the enclosure of an appliance, wiring is considered to be protected as required in 20.2.1 if, when judged as though it were film-coated wire, the wiring would be acceptable according to 9.4.2. Internal wiring not protected may be used if it is secured within the enclosure so that it is unlikely to be subjected to stress or mechanical damage.

20.2.3 A wireway shall be smooth and entirely free from any sharp edge, burr, fin, moving part, or the like that might damage the insulation on conductors.

20.2.4 A hole through which an insulated wire or 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.

20.3 Splices and connections

20.3.1 A splice or connection shall be mechanically secure and shall provide reliable electrical contact.

20.3.2 A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection might result in a risk of fire, electric shock, or injury to persons.

Exception: A connection is not required to be made mechanically secure before being soldered if a soldering or brazing material having a softening or melting point greater than 454°C (849°F) is used.

20.3.3 With reference to 20.3.2, a lead is considered mechanically secure when one or more of the following conditions are met:

a) The lead has at least one full wrap around a terminal.

b) The lead has at least one right-angle bend when the lead is passed through an eyelet or opening.

Exception: On a printed-wiring board that is soldered by a machine process in which the soldering time and solder temperature are automatically controlled, bending over of a lead after it has been passed through a hole in the board is not required.

c) The lead is twisted with one or more conductors.

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d) The lead is strapped in place, or the equivalent, adjacent to the soldered connection to hold the lead end in place.

20.3.4 The placing of a lead along a flat surface and soldering (identified as tack soldering) is not acceptable unless it can be demonstrated that a risk of fire, electric shock, or injury to persons is not likely to occur with the lead(s) detached.

20.3.5 Tack soldering of a component is acceptable if, when any one of the component's leads is unsoldered, and the component and unsoldered lead are moved to any position, the component or unsoldered lead cannot contact any part involving a risk of fire, electric shock, or injury to persons. If the tack-soldered component involves a risk of fire, electric shock, or injury to persons, when displaced, it shall not contact any other conductive part so as to increase the risk.

20.3.6 A wire-binding screw or nut shall be provided with a lock washer under the head of the screw or under the nut to prevent it from becoming loosened due to vibration if such loosening might permit shifting of parts, thereby reducing spacings or otherwise resulting in a risk of fire, electric shock, or injury to persons.

20.3.7 An open-end spade lug is not acceptable unless additional means (such as upturned ends on the tangs of the lug) are provided to hold the lug in place if the wire-binding screw or nut becomes loosened.

20.3.8 The means of connecting stranded internal wiring to a wire-binding screw shall be such that loose strands of wire will be prevented from contacting other live parts not always of the same polarity as the wire and from contacting dead-metal parts. This can be accomplished by using a pressure terminal connector, soldering lug, or crimped eyelet, and by soldering all strands of the wire together, or by means that have been determined to be the equivalent.

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

20.3.10 Insulation consisting of at least two layers of thermoplastic tape or one layer of friction tape on top of one layer of rubber tape is acceptable on a splice if the voltage involved is not more than 250 volts. In determining whether splice insulation consisting of coated fabric, thermoplastic, or other type of tubing is acceptable, consideration is to be given to such factors as dielectric properties, heat- and moisture-resistant characteristics, and the like. Thermoplastic tape wrapped over a sharp edge shall not be used.

20.3.11 Quick-connect type wire connectors shall be suitable for the wire size, type (solid or stranded), conductor material (copper or aluminum) and the number of conductors terminated. If insulated, they shall be rated for the voltage and temperature of the intended use. They shall be applied per the installation instructions of the wire connector manufacturer.

20.3.12 Quick-connect terminals, both connectors and tabs, for use with one or two 22 – 10 AWG copper conductors, having nominal widths of 2.8, 3.2, 4.8, 5.2, and 6.3 mm (0.110, 0.125, 0.187, 0.205, and 0.250 inch), intended for internal wiring connections in appliances, or for the field termination of conductors to the appliance, shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310.

Exception: Other sizes of quick-connect terminals shall be investigated with respect to crimp pull out, insertion-withdrawal, temperature rise, and all tests shall be conducted in accordance with UL 310.

20.3.13 Wire connectors shall comply with the Standard for Wire Connectors, UL 486A-486B.

20.3.14 Splicing wire connectors shall comply with the Standard for Splicing Wire Connectors, UL 486C.

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20.3.15 Single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment, and that are intended for factory assembly to copper or copper alloy conductors, or for factory assembly to printed wiring boards, shall comply with the Standard for Component Connectors for Data, Signal, Control and Power Applications, UL 1977.

20.3.16 Multi-pole splicing wire connectors that are intended to facilitate the connection of hard-wired utilization equipment to the branch-circuit conductors of buildings shall comply with the Standard for Insulated Multi-Pole Splicing Wire Connectors, UL 2459.

20.3.17 Equipment wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

20.3.18 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059, and, if applicable, be suitably rated for field wiring.

Exception: A fabricated part performing the function of a terminal block need not comply with UL 1059 if the part complies with the requirements of:

a) Pin Terminals, Section 16.5;

b) Live Parts, Section 17;

c) Electrical Insulation, Section 23; and

d) Spacings, Section 34.

of this standard. This exception does not apply to protective conductor terminal blocks.

20.4 Interconnecting cord and cable

20.4.1 A flexible cord or a cable assembly may be used for external interconnections if flexibility is essential. A flexible cord or cable assembly used for external connection between sections of equipment or between equipment shall meet the following conditions:

a) Be equivalent to the power-supply cord that would be required in a similar application.

Exception: A flexible cord or cable assembly one grade less serviceable than the power supply cord (for example, Type SJT instead of Type ST and Type SVT instead of Type SJT) may be used if it is partially protected from continuous mechanical abuse because of its short length not enabling it to be located on the floor, its location, its routing, and the like.

b) Be provided with bushings and strain relief in accordance with 16.6.1 – 16.7.5.

Exception: Cords or cables in low-voltage circuits or in secondary circuits covered in 36.1.1 – 36.2.2 need not comply with this requirement unless stress on the cord or cable could cause the internal wiring of the secondary circuits to contact live parts of other circuits that can result in a risk of electric shock.

20.4.2 Insertion of a male connector into a female connector other than one intended to receive it, misalignment of male and female connectors, and other manipulations of parts that are in an operator access area shall not result in a risk of fire, electric shock, or injury to persons.

20.4.3 If either end of an external interconnecting cable terminates in a connector having one or more exposed contacts, risks of electric shock shall not exist between any contacts, or between earth ground

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and any contact that is exposed on either the connector or its receptacle while the connector is out of its receptacle.

20.4.4 Inclusion of an interlock circuit in the cable to de-energize the exposed contacts whenever an end of the cable is disconnected constitutes compliance with the requirement in 20.4.3.

20.5 Separation of circuits

20.5.1 Unless provided with insulation rated for the highest voltage involved, insulated conductors of circuits connected to separate sources of supply shall be separated by barriers or segregated as described in 20.5.2. Other than as described in 20.5.3, an insulated conductor of one circuit shall be separated or segregated from any uninsulated live parts of a different circuit.

20.5.2 Segregation of insulated conductors may be accomplished by clamping, routing, or an equivalent means which provides permanent separation from insulated or uninsulated live parts of a different circuit.

20.5.3 Field-installed conductors of any circuit shall be separated by barriers from:

a) Field-installed and factory-installed conductors connected to any other circuit, unless the conductors of both circuits are or will be insulated for the maximum voltage of either circuit and

b) Uninsulated live parts of any other circuit of the appliance, and from any uninsulated live parts whose short-circuiting would result in risk of fire or electric shock except that:

1) A construction in which field-installed conductors may make contact with wiring terminals may be used if Type T, Type TF, or conductors that have been determined to be the equivalent are, or will be installed and

2) A construction in which field-installed conductors which do or may have insulation less than the types of wire mentioned in (1) may make contact with low-voltage wiring terminals is acceptable, provided that the short-circuiting of such terminals would not result in a risk of fire, electric shock, or injury to persons.

20.5.4 With respect to 20.5.3(a), if the intended uses of an appliance are such that in some applications a barrier is required, a removable barrier or one having an opening for the passage of conductors may be employed provided instructions for the use of the barrier are a permanent part of the appliance. Complete instructions in conjunction with a wiring diagram may be used instead of a barrier if, upon investigation, the combination is found to be adequate.

20.5.5 Segregation of field-installed conductors from other field-installed conductors and from uninsulated live parts of an appliance connected to different circuits may be accomplished by arranging the location of the openings in the enclosure for the various conductors (with respect to the terminals or other uninsulated live parts) so that there is no risk of the intermingling of the conductors or parts of different circuits. If the number of openings in the enclosure does not exceed the minimum required for the proper wiring of the appliance, and if each opening is located opposite a set of terminals, it is to be assumed (for the purpose of determining whether the appliance complies with the requirement in 20.5.3) that the conductors entering each opening will be connected to the terminals opposite the opening. If more than the minimum number of openings are provided, the possibility of conductors entering at points other than opposite the terminals to which they are intended to be connected and contacting insulated conductors or uninsulated current-carrying parts connected to a different circuit is to be investigated. To determine whether the appliance complies with the requirement in 20.5.3, it is to be wired as it would be in service, and in doing so, a reasonable amount of slack is to be left in each conductor, within the enclosure, and no more than average care is to be exercised in stowing this slack in the wiring compartment.

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20.6 Barriers

20.6.1 If a barrier is used to provide separation between the wiring of different circuits, it shall be of metal or of insulating material, of adequate mechanical strength if exposed or otherwise likely to be subjected to mechanical damage, and reliably held in place. Unclosed openings in a barrier for the passage conductors shall be not larger in diameter than 1/4 inch (6.4 mm) and shall not exceed in number, on the basis of one opening per conductor, the number of wires that will need to pass through the barrier. The closure for any other opening shall present a smooth surface wherever an insulated wire may be in contact with it, and the area of any such opening, with the closure removed, shall be not larger than required for the passage of the necessary wires.

20.6.2 A metal barrier shall have a thickness at least equal to the minimum required thickness of the enclosure metal. A barrier of insulating material shall be not less than 0.028 inch (0.71 mm) thick and shall be thicker if its deformation may be readily accomplished so as to defeat its purpose.

20.7 Termination of aluminum conductors

20.7.1 Insulated or uninsulated aluminum conductors used as internal wiring, such as for interconnection between current-carrying parts or as motor windings, shall be terminated at each end by a method acceptable for the combination of metals involved at the connection point.

20.7.2 With reference to 20.7.1, 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).

21 Heating Element

21.1 A heating element shall be supported in an acceptable manner and shall be protected against mechanical damage and contact with outside objects.

21.2 In determining whether a heating element is supported, consideration is to be given to sagging, loosening, and other adverse conditions of the element resulting from continuous heating.

21.3 An appliance in which the heating element is designed for operation only in an air stream shall be so wired or controlled that the element is operated only when under the cooling effect of the stream.

21.4 An open-wire heating element or the like shall be judged under the applicable requirements of this Standard.

21.5 Insulated heating wire shall comply with the Standard for Appliance Wiring Material, UL 758.

21.6 Thermistor-type heaters (e.g. PTC heaters) shall comply with the Standard for Thermistor-Type Devices, UL 1434.

22 Sheathed Heating Element

22.1 A sheathed heating element shall comply with the Standard for Sheathed Heating Elements, UL 1030 or the Standard for Electric Heating Appliances, UL 499.

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23 Electrical Insulation

23.1 General

23.1.1 An insulating washer, bushing, and the like that is an integral part of an appliance and a base or support for the mounting of a current-carrying part shall be of a moisture-resistant material that will not be adversely affected by the temperatures to which it will be subjected under conditions of intended use. Molded parts shall be so constructed that they will have the strength and rigidity to withstand the stresses of intended service.

23.1.2 Insulating material used in an appliance is to be judged with respect to its acceptability for the particular application. Materials such as mica and certain refractory materials are usually acceptable for use as the sole support of live parts. Other materials not acceptable for general use, such as magnesium oxide, may be used if used in conjunction with other insulating materials, or if so located and protected that the risk of mechanical damage and the absorption of moisture are reduced. When it is necessary to investigate a material to determine its acceptability, consideration is to be given to its mechanical strength, insulation resistance, heat-resistant qualities, the degree to which it is enclosed or protected, and any other features having a bearing on the risk of fire, electric shock, or injury to persons involved in conjunction with conditions of service. All these factors are to be considered with respect to thermal aging.

23.1.3 A polymeric material used for direct or indirect support of a live part or as electrical insulation shall comply with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: Molded phenolic and urea may be used without further investigation if the temperature on the part does not exceed 150°C(302°F) and 100°C (212°F), respectively, as measured during the temperature test.

23.1.4 In the mounting or supporting of a small fragile insulating part, a screw or other fastening is not to be so tight as to result in cracking or breaking with expansion and contraction. Generally, such a part should be slightly loose.

23.1.5 A small molded part, such as a brush cap, shall be so constructed that it will have strength and rigidity to withstand stresses during intended use.

23.1.6 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill the requirements of 23.1.2 or a performance requirement of this standard. In such cases:

a) Insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510;

b) Sleeving shall comply with the Standard for Coated Electrical Sleeving, UL 1441;

c) Tubing shall comply with the Standard for Extruded Insulating Tubing, UL 224.

23.2 Film-coated wire (magnet wire)

23.2.1 The component requirements for film coated wire and Class 105 (A) insulation systems are not specified.

23.2.2 Film coated wire in intimate combination with one or more insulators, incorporated with an insulation system rated Class 120 (E) or higher, shall comply with the magnet wire requirements in the Standard for Systems of Insulating Materials – General, UL 1446 and shall have a suitable temperature class.

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23.2.3 Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with the requirements specified in the Standard for Systems of Insulating Materials – General, UL 1446.

23.2.4 All insulation systems employing integral ground insulation shall comply with the requirements specified in the Standard for Systems of Insulating Materials – General, UL 1446.

24 Thermal Insulation

24.1 Combustible thermal and electrically conductive insulation shall not contact an uninsulated live part.

24.2 Some types of mineral wool thermal insulation contain conductive impurities in the form of slag. Such insulation shall not be used in contact with any uninsulated live part which may involve a risk of fire, electric shock, or injury to persons.

24.3 Thermal insulation shall be rated for the temperature to which it is exposed when tested under the conditions described in 46.1.1.

25 Overcurrent Protection

25.1 If overcurrent conditions are likely to occur, the appliance shall be provided with a circuit breaker or fuse.

25.2 A protective device, the intended functioning of which requires replacement or resetting, shall be in a readily accessible location.

25.3 Overcurrent protection at not more than 20 amperes shall be provided by means of a circuit breaker or fuse in the appliance for each general use receptacle circuit and each lampholder circuit in the appliance, unless the appliance would be correctly connected to a branch circuit rated at 20 amperes or less.

25.4 The overcurrent protection mentioned in 25.3 shall be of a type rated for branch circuit protection.

25.5 A fuseholder shall be constructed and installed so that no uninsulated live parts other than the screw shell or clips will be exposed to contact by a person removing or replacing a fuse. The screw shell of a plug-type fuseholder shall be connected toward the load.

25.6 For other than a hand-supported appliance, if the handle of a circuit breaker is operated vertically rather than rotationally or horizontally, the up position of the handle shall be the on position.

25.7 Fuses shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1; and the applicable UL 248 Part 2 (e.g. the Standard for Low-Voltage Fuses – Part 5: Class G Fuses, UL 248-5). Defined use fuses that comply with UL 248-1 and another appropriate UL standard for the fuse are considered to comply with this requirement

25.8 Fuseholders shall comply with the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1, and the applicable Part 2 (e.g. the Standard for Fuseholders – Part 9: Class K, UL 4248-9).

25.9 When provided, circuit breakers shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

Exception: Circuit breakers used in telecommunications circuitry that comply with the Standard for Circuit Breakers For Use in Communications Equipment, UL 489A need not comply with UL 489.

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25.10 Circuit breakers having integral ground fault circuit interrupter capability for protection against electrical shock shall additionally comply with the Standard for Ground-Fault Circuit-Interrupters, UL 493.

25.11 Supplementary protectors shall comply with the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077.

26 Thermal Cutoffs

26.1 If a thermal cutoff is employed to reduce the risk of fire, electric shock, or injury to persons due to an appliance overheating during abnormal operation, the thermal cutoff shall comply with:

a) The Standard for Thermal-Links – Requirements and Application Guide, UL 60691, and

b) The applicable requirements in this standard.

27 Lampholders and Receptacles

27.1 Lampholders and indicating lamps integral with lampholders shall comply with the Standard for Lampholders, UL 496. A female screw shell used as a holder for a heating element shall be of copper or of copper alloy and shall be plated with nickel or an equivalent oxidation-resistant metal.

27.2 The circuit conductor of a power supply cord or circuit that is intended to be grounded shall have the following connected to it:

a) The screw shell of an Edison-base lampholder and

b) The terminal or lead of a receptacle intended to be grounded.

Table 16.8 identifies the supply cord conductor intended to be grounded.

27.3 An Edison-base lampholder shall not be used in an appliance rated more than 150 volts.

Exception: An Edison-base lampholder may be used if the construction is such that live parts of the lampholder and the lamp will not be exposed to contact by persons when the screw shell of the lamp is in contact with live parts of the lampholder or if used on a three-wire Edison system.

27.4 An Edison-base lampholder in an appliance rated 150 volts or less shall be so constructed or installed that an uninsulated live part other than the screw shell will not be exposed to contact by a person removing or replacing a lamp during intended service.

Exception: This requirement is not applicable to an appliance for which it is necessary to dismantle the appliance or remove a cover plate or other part by means of a tool to remove or replace a lamp or an appliance that is permanently and legibly marked to indicate that such relamping is to be done with the appliance disconnected from the supply source. See 79.1.7 for additional marking information.

27.5 A 15- or 20-ampere attachment plug receptacle intended for general use in an appliance shall be of the grounding type. The grounding contact of the receptacle shall be electrically connected to dead- metal that will be grounded when the appliance is in use.

27.6 Attachment plug receptacles shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

27.7 The face of a receptacle that is less than 5/8 inch (15.9 mm) wide or 7/8 inch (22.2 mm) long shall project a minimum of 0.015 inch (0.38 mm) and a maximum of 3/16 inch (4.8 mm) from the part of the

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receptacle-mounting surface that is within a rectangle 5/8 inch wide and 7/8 inch long, the rectangle being symmetrically located about the receptacle contacts.

27.8 If the mounting surface for the receptacle described in 27.7 is electrically conductive, the face of the receptacle shall project a minimum of 3/32 inch (2.4 mm).

27.9 An appliance provided with one or more general use receptacles shall not be equipped with a flexible cord smaller than 16 AWG (1.3 mm^2).

27.10 If an appliance includes one or more receptacles intended for general use and if the overcurrent protection of a branch circuit to which the appliance will correctly be connected will be inadequate for the receptacle or receptacles, a single receptacle shall have overcurrent protection of not more than 15 amperes provided as part of the appliance, and two or more receptacles (including a single duplex receptacle) shall have overcurrent protection of not more than 20 amperes.

28 Light Sources and Associated Components

28.1 Lighting ballasts shall comply with:

a) The Standard for Fluorescent-Lamp Ballasts, UL 935 or

b) The Standard for High-Intensity Discharge Lamp Ballasts, UL 1029.

Ballasts forming part of a luminaire that complies with an appropriate luminaire standard are considered to fulfill this requirement.

Exception: Ballasts for other light sources shall comply with the appropriate standard(s) and need not comply with UL 935 or UL 1029.

28.2 Light emitting diode (LED) light sources shall comply with the Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products, UL 8750. LED light sources forming part of a luminaire that complies with an appropriate luminaire standard are considered to fulfill this requirement.

Exception: Individual LED light sources intended for indicating purposes only, need not comply with UL 8750.

29 Capacitors

29.1 A capacitor provided as a part of a capacitor 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 shall protect the plates against mechanical damage and prevent the emission of flame or molten material resulting from malfunction of the capacitor. The container shall be of metal providing strength and protection not less than that of uncoated steel having a thickness of 0.020 inch (0.51 mm).

Exception No. 1: A capacitor shall comply with the Standard for Capacitors, UL 810; an electromagnetic interference filter with an integral enclosure complying with the Standard for Electromagnetic Interference Filters, UL 1283; and an across the line capacitor shall comply with the requirements in the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14, are considered to be adequately protected.

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Exception No. 2: The individual container of a capacitor may be of sheet metal less than 0.020-inch thick 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.

29.2 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 reduce such a risk.

29.3 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 µF. The capacitor shall comply with the applicable requirements in the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14.

29.4 The voltage rating of a capacitor other than a motor-starting or motor-running capacitor shall equal or exceed the maximum steady-state potential to which the capacitor is subjected during operation of the unit at the rated voltage.

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

30 Printed-Wiring Boards

30.1 A printed-wiring board used in a primary circuit and in a secondary circuit where separation of a conductor from the base material might result in the conductor contacting uninsulated parts involving a risk of fire or electric shock shall comply with the Standard for Printed-Wiring Boards, UL 796.

30.2 A resistor, capacitor, inductor, transformer, or other part mounted on a printed-wiring board to form a printed-wiring assembly shall be secured so that it cannot be displaced by any forces exerted on it which can result in a risk of fire, electric shock, or injury to persons during assembly, operation, or servicing.

30.3 Consideration is to be given to the mechanical protection and electrical insulation afforded to the part by a partition.

30.4 A printed-wiring board containing circuitry in a line-connected circuit or a safety circuit shall comply with the direct-support requirements for insulating materials in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluation, UL 746C and have a flammability rating of V-1 or better.

Exception: A printed-wiring board containing Class 2 non-safety circuit only is required to comply with the Standard for Printed-Wiring Boards, UL 796 with flammability rating of HB or better.

30.5 Unless otherwise specified, the flammability class and temperature rating shall be that specified for insulating materials in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluation, UL 746C.

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31 Switches

31.1 General

31.1.1 An appliance having any driven moving part, which by function could cause entrapment of hair, body parts, clothing, or the like, shall be provided with a main on-off switch. Appliances in this group include, but are not limited to, hair dryers and hair untanglers.

31.1.2 The switch required in 31.1.1 shall be located so that it can be operated by the user to shut off power to the unit.

31.1.3 A switch shall be rated for the particular application and shall have a current and voltage rating not less than that of the circuit (load) it controls.

31.1.4 Manually operated snap-switches shall comply with one of the following, as applicable:

a) Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1;

b) Standard for Special-Use Switches, UL 1054;

c) Standard for General-Use Snap Switches, UL 20; or

d) Standard for Nonindustrial Photoelectric Switches for Lighting Control, UL 773A.

Exception: Switching devices that comply with the appropriate UL standard for specialty applications (e.g. transfer switch equipment), industrial use (e.g. contactors, relays, auxiliary devices), or are integral to another component (e.g. switched lampholder) need not comply with this requirement.

31.1.5 A clock-operated switch, in which the switching contacts are actuated by a clock-work, by a gear-train, by electrically-wound spring motors, by electric clock-type motors, or by equivalent arrangements shall comply with one of the following:

a) 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 Timers and Time Switches, UL 60730-2-7 or

b) The Standard for Clock-Operated Switches, UL 917.

31.1.6 A timer or time switch, incorporating electronic timing circuits or switching circuits, with or without separable contacts, shall comply with the requirements for an operating control with Type 1 action for 6000 cycles of operation, or as a manual control for 5000 cycles of operation, in accordance with the following:

a) 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 Timers and Time Switches, UL 60730-2-7 or

b) The Standard for Solid-State Controls for Appliances, UL 244A.

31.1.7 A switch required by 31.1.1 shall be able to withstand 30,000 cycles of operation.

31.1.8 With reference to the requirement in 31.1.3 the current rating of a switch that controls an inductive load, such as a transformer or a fluorescent-lamp ballast, shall be not less than twice the rated full-load current of the transformer or ballast, unless the switch is known to be rated for the particular application.

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31.1.9 A switch that controls an incandescent lamp or lamps shall be rated for use with tungsten-filament lamps.

31.1.10 A switch is considered suitable for the control of a tungsten-filament lamp load if:

a) It has a "T" or "L" rating and a current rating at least equal to the tungsten-filament lamp load or

b) It has an alternating-current rating at least six times or a direct-current rating at least ten times that of the tungsten-filament lamp load.

31.1.11 If an appliance provided with a power supply cord and an attachment plug employs a motor rated more than 1/3 horsepower (250 watts output), a motor controller (a device for starting and stopping the motor) shall be provided in the appliance.

31.1.12 A manually operated, line-connected, single-pole switch for appliance on-off operation shall not be connected to the conductor of the power supply cord or circuit intended to be grounded. Table 16.8 identifies the power supply cord conductor intended to be grounded.

31.1.13 A switch that is subjected to a temperature of more than 65°C (149°F) is to be judged with respect to the temperature limitations of the materials used.

31.1.14 A switch shall be so located or protected that it will not be subjected to mechanical damage during use.

31.1.15 A switch as required in 31.1.1 and 31.1.16 shall have a plainly marked "off" position. The use of a symbol, such as the symbol O, alone is not acceptable to denote the "off" position. The switch position marking need not be an integral part of the switch itself.

Exception: An appliance that is provided with a momentary-contact, on-off switch that automatically returns to the "off" position when the actuator is released does not need to have a marked "off" position.

31.1.16 A hand-supported hair dryer shall be provided with a main on-off switch.

31.2 Dual voltage selector

31.2.1 The construction of the supply circuit voltage selector shall be such that the supply circuit voltage setting cannot be changed without the use of a tool.

31.2.2 If the appliance is so constructed that the supply circuit voltage selector setting can be changed, the action of changing the voltage selector setting shall also change the supply circuit voltage indication.

31.2.3 An appliance that can be set to different rated supply circuit voltages shall be provided with the statement required in 81.9(k)(12).

32 Automatic Controls

32.1 General

32.1.1 The operation of an automatic control device in an appliance shall disconnect the element or elements it controls from all ungrounded conductors of the supply circuit.

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Exception: Disconnection of all ungrounded conductors of the supply circuit is not required if there is no uninsulated live part exposed to unintentional contact when the switch is open, or if the fact that such a part is live is definitely apparent.

32.1.2 Breakdown of a temperature control in a hand-supported hair dryer shall not result in a risk of fire, electric shock, or injury to persons; therefore, the appliance is to be tested in accordance with 50.3.12.1 – 50.3.14.3. A limit control in a hand-supported hair dryer that operates to interrupt all heater and motor circuits and to end the test shall be in accordance with Thermal Cutoffs, Section 26.

32.1.3 Temperature-regulating control and temperature-limiting control shall comply with the requirements of the overload test described in 66.1 and the endurance test described in 66.2.

32.1.4 The overload and endurance tests of a temperature controller consisting of a temperature sensor and the associated control circuit for an appliance having a preheat cycle shall be conducted in the appliance, or under conditions representative of those in the appliance, as described in the Automatic Controls Tests, Section 66.

32.1.5 A temperature controller that controls the duration of a preheat cycle by a timing circuit or by an equivalent means without using a temperature sensor is considered to be a temperature-regulating control and shall comply with the overload and endurance requirements specified in the Automatic Controls Tests, Section 66.

32.1.6 Auxiliary controls shall be evaluated in accordance with the applicable requirements of this standard and the parameters in Controls – End Product Test Parameters, Section 33, unless otherwise specified in this standard. See 32.1.12.

32.1.7 Operating (regulating) controls shall be evaluated in accordance with the applicable component standard requirements specified in 32.2, if applicable, and the parameters in Controls – End Product Test Parameters, Section 33, unless otherwise specified in this standard. See 32.1.12.

32.1.8 Operating controls that rely upon software for the normal operation of the end product where deviation or drift of the control may result in a risk of fire, electric shock, or injury to persons, such as a speed control unexpectedly changing its output, shall comply with one of the following:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, and the Standard for Software in Programmable Components, UL 1998 or

b) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

See 33.4.

32.1.9 Protective (limiting) controls shall be evaluated in accordance with the applicable component standard requirements specified in 32.2 and if applicable, the parameters in Controls – End Product Test Parameters, Section 33, unless otherwise specified in this standard.

32.1.10 Solid-state protective controls that do not rely upon software as a protective component shall comply with one of the following:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 or

b) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1 except the Controls Using Software requirements, Clause H 11.12.

See 33.4.

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32.1.11 Solid-state protective controls that rely upon software as a protective component shall comply with one of the following:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 and the Standard for Software in Programmable Components, UL 1998 or

b) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

See 33.4.

32.1.12 An electronic, auxiliary or operating control (e.g. a non-protective control), the failure of which would not increase the risk of fire, electric shock, or injury to persons (i.e. burn injury), is not required to comply with the requirements in 32.1.7 – 32.1.12 and is only required to be subjected to the applicable requirements of this standard

32.2 Electromechanical and electronic controls

32.2.1 A temperature control shall comply with one of the following:

a) The Standard for Temperature-Indicating and -Regulating Equipment, UL 873;

b) The Standard for Limit Controls, UL 353; or

c) 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.

32.2.2 A temperature control, described in 4.47, installed in a hand-supported hair dryer that is tested for compliance with the requirements in this standard shall operate at not more than 8.3°C (15°F) above or below its rated operating temperature, as determined by subjecting the control, a subassembly including the control, or the complete appliance to the appropriate temperatures in an air oven.

32.2.3 In a wax depilatory appliance, an automatic-reset regulating temperature control shall be a calibrated control endurance tested for at least 30,000 cycles of operation and shall comply with all other requirements applicable to limit controls in the Standard for Limit Controls, UL 353, or the requirements applicable to temperature-limiting controls in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873. The calibration requirements shall be as specified for water-heater limit controls in UL 353 or water-heater temperature-limiting controls in UL 873. Compliance with 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, fulfills the UL 873 requirements.

32.2.4 A temperature sensing positive temperature coefficient (PTC) or a negative temperature coefficient (NTC) thermistor, that performs the same function as an operating or protective control shall comply with:

a) 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 with Annex J or

b) The Standard for Thermistor-Type Devices, UL 1434.

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33 Controls – End Product Test Parameters

33.1 General

33.1.1 Spacings of controls shall comply with the electrical spacing, or clearances and clearance distance requirements of the applicable control standard as determined in Spacings, Section 34 and Spacings on Printed Wiring Boards, Section 35.

33.1.2 Where reference is made to declared deviation and drift, this indicates the manufacturer's declaration of the control's tolerance before and after certain conditioning tests.

33.2 Auxiliary controls

33.2.1 Auxiliary controls shall not introduce a risk of electric shock, fire, or personal injury.

33.2.2 Auxiliary controls shall comply with the requirements of this standard.

Exception: An auxiliary control that complies with a component standard(s) specified in 31.2 and is considered to fulfill this requirement.

33.3 Operating controls (regulating controls)

33.3.1 The following test parameters shall be among the items considered when judging the acceptability of an operating control investigated using the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1:

a) Control action Types 1 or 2;

b) Unless otherwise specified in this standard, manual and automatic controls shall be tested for 6,000 cycles with under maximum normal load conditions, and 50 cycles under overload conditions;

c) Installation Class 2 per the Standard for Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test, IEC 61000-4-5

d) For the applicable Overvoltage Category, see Table 33.1;

e) For the applicable Material Group, see Table 33.2;

f) For the applicable Pollution Degree, see Table 33.3.

33.3.2 The following test parameters shall be among the items considered when judging the acceptability of an operating control investigated using other than the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1:

a) Control action Types 1 or 2;

b) Unless otherwise specified in this standard, manual and automatic controls shall be tested for 6,000 cycles with under maximum normal load conditions, and 50 cycles under overload conditions;

c) For the applicable Overvoltage Category, see Table 33.1;

d) For the applicable Material Group, see Table 33.2;

e) For the applicable Pollution Degree, see Table 33.3.

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Table 33.1
Overvoltage categories

Appliance	Overvoltage category
Intended for fixed wiring connection	III
Portable and stationary cord-connected	II
Control located in low-voltage circuit	I
NOTE – Applicable to low-voltage circuits if a short circuit between the parts involved may result in operation of the controlled equipment that would increase the risk of fire or electric shock.	

Table 33.2
Material group

CTI PLC value of insulating materials	Material group
CTI ≥ 600 (PLC = 0)	I
400 ≤ CTI < 600 (PLC = 1)	II
175 ≤ CTI < 400 (PLC = 2 or 3)	IIIa
100 ≤ CTI < 175 (PLC = 4)	IIIb
NOTE – PLC stands for Performance Level Category, and CTI stands for Comparative Tracking Index as specified in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.	

Table 33.3
Pollution degrees

Appliance control microenvironment	Pollution degree
No pollution or only dry, nonconductive pollution. The pollution has no influence. Typically hermetically sealed or encapsulated control without contaminating influences, or printed wiring boards with a protective coating can achieve this degree.	1
Normally, only nonconductive pollution. However, a temporary conductivity caused by condensation may be expected. Typically indoor appliances for use in household or commercial clean environments achieve this degree.	2
Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation that is expected. Typically controls located near and may be adversely affected by motors with graphite or graphite composite brushes, or outdoor use appliances achieve this degree.	3

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33.4 Protective controls (limiting controls)

33.4.1 An electronic control that performs a protective function shall comply with the applicable requirements in Automatic Controls, Section 32 while tested using the parameters in this Section. Examples of protective controls are:

a) A control used to sense abnormal temperatures of components within the appliance;

b) An interlock function to de-energize a motor;

c) Temperature protection of the motor due to locked rotor, running overload, loss of phase; or

d) Other function intended to reduce the risk of electric shock, fire, or injury to persons.

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33.4.2 The following test parameters shall be among the items considered when determining the acceptability of an electronic protective control investigated using the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1:

a) Failure-Mode and Effect Analysis (FMEA) or equivalent Risk Analysis method;

b) Power Supply Voltage Dips, Variation and Interruptions within a temperature range of 10°C (18°F) and the maximum ambient temperature determined by conducting the Temperature Test; Section 46;

c) Surge Immunity Test – installation Class 3 shall be used;

d) Electrical Fast Transient/Burst Test, a test level 3 shall be used;

e) Electrostatic Discharge Test;

f) Radio-Frequency Electromagnetic Field Immunity:

1) Immunity to conducted disturbances – When applicable, test level 3 shall be used and

2) Immunity to radiated electromagnetic fields; field strength of 3 V/m shall be used;

g) Thermal Cycling test shall be conducted at ambient temperatures of 10.0 +2°C (50.0 ±3°F) and the maximum ambient temperature determined by conducting the Temperature Test, Section 46. The test shall be conducted for 14 days;

h) Overload shall be conducted based on the maximum declared ambient temperature (T_{max}) or as determined by conducting the Temperature Test, Section 46; and

i) If software is relied upon as part of the protective electronic control, it shall be evaluated as software Class B.

33.4.3 The test parameters and conditions used in the investigation of the circuit covered by 33.4.1 shall be as specified in the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, using the following test parameters:

a) With regard to electrical supervision of critical components, for attended appliances, a motor operated system becoming permanently inoperative with respect to movement of an exposed portion of the appliance meets the criteria for trouble indication. For unattended appliances, electrical supervision of critical components may not rely on trouble indication;

b) A field strength of 3 V/m is to be used for the Radiated EMI Test;

c) The Composite Operational and Cycling Test is to be conducted for 14 days at temperature extremes of 0°C (32°F) and 70°C (158°F);

d) The Humidity Class is to be based on the appliance's intended end use and is to be used for the Humidity Test;

e) A vibration level of 5 g is to be used for the Vibration Test;

f) The Computational Investigation is not applicable to equipment covered by this standard;

g) For the Demonstrated Method Test, the multiplier for the test acceleration factor is to be 576.30 for intermittent use appliances, or 5,763.00 for continuous use appliances. The test acceleration factor equation is to be based on a 25°C (77°F) use ambient;

h) The Endurance Test is to be conducted concurrently with the Operational Test. The control shall perform its intended function while being conditioned for 14 days in an ambient air temperature of

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60°C (140°F), or 10°C (18°F) greater than the operating temperature of the control, whichever is higher. During the test, the control is to be operated in a manner representing normal use;

i) For the Electrical Fast Transient Burst Test, test level 1 is to be used; and

j) Conduct a Failure-Mode and Effect Analysis (FMEA).

k) If software is relied upon as part of the protective electronic control, it shall be evaluated as software Class 1 in accordance with the Standard for Software in Programmable Components, UL 1998.

33.4.4 Unless otherwise specified in this standard, protective controls shall be evaluated for 100,000 cycles for Type 2 devices and 6,000 cycles for Type 1 devices with rated current. Also see Table 66.1 for required endurance cycles of temperature control.

34 Spacings

34.1 The spacings between field-wiring terminals of opposite polarity and the spacings between a field-wiring terminal and any other uninsulated metal part (dead or live) not of the same polarity shall be not less than indicated in Table 34.1.

Table 34.1
Spacings at field-wiring terminals

Potential involved, volts	Minimum spacings					
	Between field-wiring[a] terminals, through-air or over-surface,		Between terminals and other uninsulated parts not always of the same polarity[a]			
			Over-surface,		Through-air,	
	inch	(mm)	inch	(mm)	inch	(mm)
250 or less	1/4	(6.4)	1/4	(6.4)	1/4	(6.4)

[a] Applies to the sum of the spacings involved where an isolated dead-metal part is interposed.

34.2 In primary circuits, other than at field-wiring terminals, the spacings between an uninsulated live part and any other uninsulated metal part (dead or live) not of the same polarity shall be not less than indicated in Table 34.2. See also 34.4. If an uninsulated live part is not rigidly fixed in position, by means other than friction between surfaces, or if a movable dead-metal part is in proximity to an uninsulated live part, the construction shall be such that at least the minimum required spacing shall be maintained with the movable part in any position.

Table 34.2
Minimum primary-circuit spacings at other than field-wiring terminals or inside motors

Potential involved, volts	Over-surface, [a]		Through-air,[a]	
	inch	(mm)	inch	(mm)
125 or less	1/16	(1.6)	1/16	(1.6)
126 – 250	3/32[b]	(2.4[b])	3/32[b]	(2.4[b])

[a] On printed-wiring boards, their connectors and board-mounted electrical components, wired on the load side of line filters or similar voltage-peak-reduction networks or components, a minimum spacing of 0.023 inch (0.58 mm) plus 0.0002 inch (0.005 mm) per volt peak shall be maintained over-the-surface and through-air between an uninsulated live part and any other uninsulated conductive part (live or dead) not of the same polarity.

[b] In appliances employing heaters, such as curling irons, hair dryers, and the like, the spacings may be 1/16 inch (1.6 mm) at the heating element.

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34.3 At terminal screws and studs to which connections may be made in the field by means of wire connectors, eyelets, and the like, spacings shall be not less than those specified in Table 34.1 when such connectors, eyelets, and the like are in such position that minimum spacings between live parts of opposite polarity and live parts and dead-metal exist.

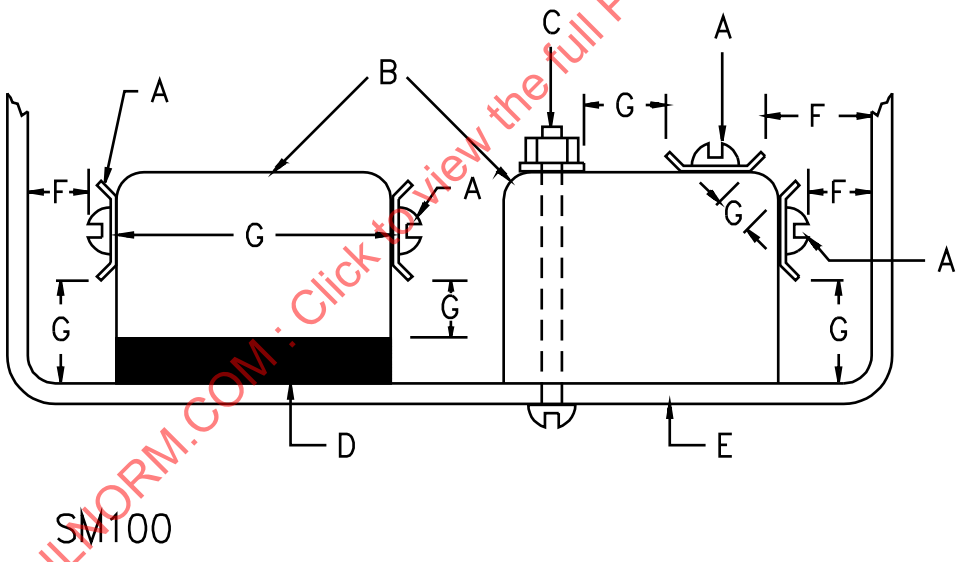
34.4 Primary-circuit spacings apply in all secondary circuits that are safety circuits and in all secondary circuits supplied by a transformer winding of 200 volt-amperes or a higher capacity (maximum available power) at a potential higher than 100 volts. The spacings in all other secondary circuits that are not safety circuits are considered on the basis of the dielectric voltage-withstand test described in 47.2.1.

34.5 Film-coated wire is to be considered as if it were an uninsulated live part for the purpose of applying spacing requirements.

34.6 The spacings specified as the minimum acceptable in Table 34.2 do not apply to the inherent spacings of a component of the appliance, such as a snap switch. The acceptability of spacings of a component is based on the requirements that cover the component. Some examples of these spacings are shown in Figure 34.1. See also General, Section 2, for requirements for components.

Figure 34.1

Spacings of components



A – Uninsulated live parts of component.

B – Insulating material of component.

C – Mounting screw of component.

D – Dead-metal parts of component.

E – Dead-metal parts of heater.

F – Spacings to which 34.2 applies.

G – Spacings to which 34.2 does not apply.

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34.7 Spacings in a motor shall comply with the spacing requirements in the Standard for Rotating Electrical Machines – General Requirements , UL 1004-1.

34.8 An insulating liner shall be rated for the purpose. Vulcanized fiber or a similar material used in lieu of required spacings shall be 1/32 inch (0.8 mm) thick or thicker and shall be so located or of such material that the material cannot be damaged by arcing. However, 1/64 inch (0.4 mm) or thicker vulcanized fiber may be used in conjunction with an additional air spacing of 50 percent or more of the spacing for air alone. Barriers shall be held in place by a means that is more secure than friction between surfaces.

Exception: Thinner insulating material may be used if it is rated for the application.

34.9 If an uninsulated live part is not rigidly fixed in position by means other than friction between surfaces, or if a movable dead-metal part is in proximity to an uninsulated live part, the construction shall be such that the required minimum spacings shall be maintained.

34.10 If an isolated, dead-metal part is interposed between or is in the proximity to:

a) Live parts of opposite polarity,

b) A live part and an exposed dead-metal part, or

c) A live part and a dead-metal part that may be grounded,

the spacing shall not be less than 3/64 inch (1.2 mm) between the isolated dead-metal part and any one of the other parts mentioned, provided the total spacing between the isolated dead-metal part and the two other parts is not less than the value specified in Table 34.2. See Figure 34.2 for spacings for isolated dead-metal parts.

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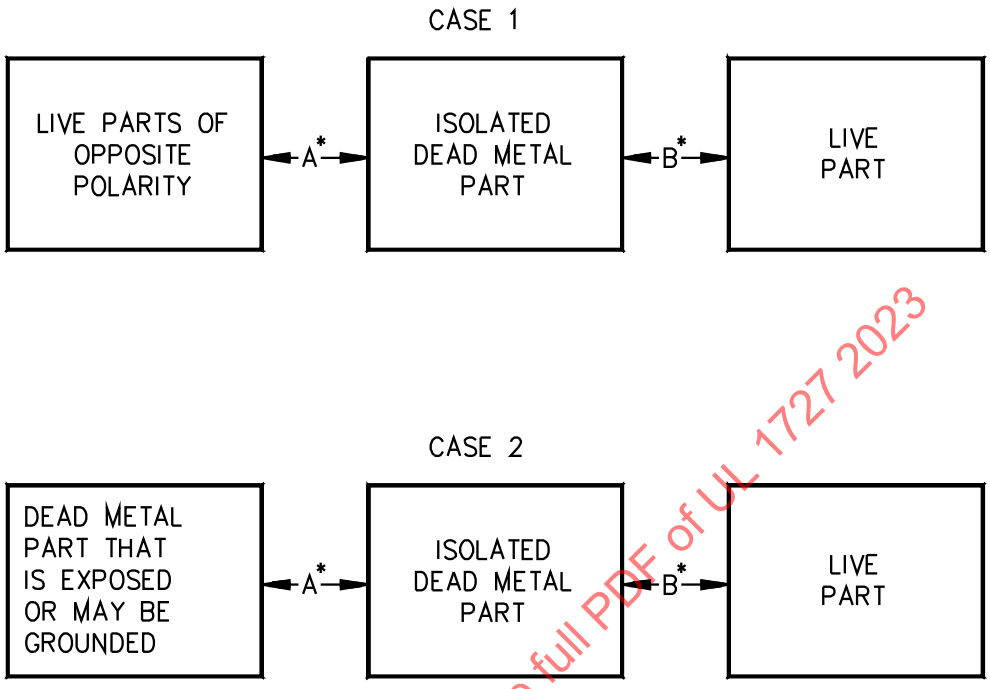
Figure 34.2

Spacings for isolated dead-metal parts



* Spacings A and B shall be at least 3/64 inch (1.2 mm); and spacing A plus spacing B shall be not less than the value indicated in Table 34.2.

34.11 Each uninsulated live part connected to different (line-voltage, low-voltage, limited-energy primary, or secondary) circuits shall be spaced from all others as though it were a part of opposite polarity, in accordance with the requirements in 34.1 and 34.2, and shall be considered as operating at the highest voltage involved.

34.12 The spacing between uninsulated live parts of opposite polarity and between such parts and dead-metal that may be grounded in service is not specified for parts of low-voltage circuits.

34.13 The spacing between uninsulated live parts of a limited-energy primary circuit is not required to be specified when:

a) The location and relative arrangement of the parts are such that permanent separation is provided and

b) The limited-energy circuit meets the applicable test requirements in the Abnormal Operation Test, Section 50.

34.14 At closed-in points only, where contamination is unlikely to occur, such as the screw-and-washer construction of an insulated terminal mounted in metal, a spacing of 3/64 inch (1.2 mm) may be used.

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35 Spacings On Printed Wiring Boards

35.1 As an alternative to the spacing requirements in Spacings, Section 34, a printed wiring board with spacings between opposite polarity circuits (other than a low-voltage circuit) less than those required is acceptable provided that the spacings:

a) Are located on a portion of the printed wiring board provided with a conformal coating that complies with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and the dielectric voltage-withstand test described in 47.2.1; or

b) Are located on the load side of a resistor such that a short circuit from the load side of the resistor to the other side of the line does not result in the resistor power dissipation exceeding the resistor wattage rating; or

c) Comply with the spacing requirements in the Standard for Solid-State Controls for Appliances, UL 244A. Compliance with the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements; or

d) Comply with the spacing requirements in Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840. The spacing requirements of UL 840 shall not be used for field wiring terminals and spacings to a dead metal enclosure.

35.2 When conducting evaluations in accordance with the requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, the following guidelines shall be used:

a) A household appliance is to be categorized as Overvoltage Category II, see Table 33.1;

b) The applicable Material Group per Table 33.2;

c) The pollution degree shall be pollution degree 2, see Table 33.3;

d) Any printed-wiring board which complies with the requirements in the Standard for Printed-Wiring Boards, UL 796, shall be determined to provide a Comparative Tracking Index (CTI) of 100, and when it further complies with the requirements for Direct Support in UL 796 then it shall be determined to provide a CTI of 175.

35.3 In order to apply clearance B (controlled overvoltage) clearances, control of overvoltage shall be achieved by providing an overvoltage device or system as an integral part of the product. This voltage limiting device or system shall comply with the Standard for Surge Protective Devices, UL 1449.

36 Secondary Circuits

36.1 General

36.1.1 Secondary circuits are to be investigated under the requirements in this standard. See 4.45.

Exception No. 1: The secondary circuits specified in 36.1.2 – 36.2.2 need not be investigated under the requirements in this standard.

Exception No. 2: All secondary circuits that are safety circuits are to be investigated under the requirements for primary circuits in this standard.

36.1.2 Circuits supplied by a single source consisting of an isolating transformer, or a power supply that includes an isolating transformer, are acceptable if the open-circuit potential is not more than 42.4 volts

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peak and the energy available to the circuit is limited so that the current under any condition of load including short circuit is not more than 8 amperes measured after 1 minute of operation.

36.1.3 A Class 2 power supply shall comply with the Standard for Class 2 Power Units, UL 1310.

36.1.4 A Class 2 transformer shall comply with 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.

36.1.5 With reference to the voltage limit specified in 36.1.2 measurement is to be made with the appliance, the power supply, or the transformer primary connected to the voltage described in 40.2 and all loading circuits disconnected from the transformer or the power supply under test. Measurement may be made at the output terminals of the transformer or power supply. If a tapped transformer is used to supply a full-wave rectifier, voltage measurements are to be made from each end of the winding to the tap.

36.1.6 If the available short-circuit current of the power supply mentioned in 36.1.2 is not limited by construction of the transformer, but the circuit includes either a fixed impedance, a fuse, a nonadjustable manual-reset-circuit-protective device, or an acceptable regulating network, the circuits in which the current is limited in accordance with 36.1.7 or 36.1.8 need not be tested.

36.1.7 A secondary fuse or circuit protective device used to limit the current in accordance with 36.1.8 shall be rated or set at not more than the values specified in Table 36.1. Equivalent primary protection may be provided.

Table 36.1
Rating for fuse or circuit protector

Open-circuit volts peak	Amperes
0 – 21.2	5
21.3 – 42.4	3.2

36.1.8 A fixed impedance or regulating network used to limit the current in accordance with 36.1.6 shall be such that the current under any condition of load including short circuit does not exceed 8 amperes measured after 1 minute of operation.

36.1.9 If a regulating network is used to limit the voltage or current in accordance with 36.1.2 and 36.1.6 the performance of the network shall not be impaired by a malfunction, either by short-circuit or open-circuit, of any single component in the network. The risk of such malfunction occurring shall be determined by investigation of that component.

36.1.10 In a circuit of the type described in 36.1.6 the secondary winding of the transformer, the fuse or circuit-protective device, or the regulating network and all wiring up to the point at which the current and voltage are limited shall be investigated under the applicable requirements in this standard.

36.1.11 General purpose transformers shall comply with:

a) The Standard for Low Voltage Transformers: General Requirements, UL 5085-1; and

b) The Standard for Low Voltage Transformers: General Purpose Transformers, UL 5085-2; and

c) The Standard for Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411.

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36.2 Connections to frame

36.2.1 Secondary circuits may be connected to the frame of the appliance.

36.2.2 If the frame is used as a current-carrying part of a secondary circuit, hinges or other movable parts shall not be used as a current-carrying means.

37 Conformal Coatings

37.1 A conformal coating that is used to cover electrical conductors shall comply with the requirements for a conformal coating in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. If the coating is subjected to vibration, mechanical abuse, or the equivalent, additional testing (such as a vibration test) may be necessary.

38 Grounding

38.1 General

38.1.1 An appliance shall have provision for the grounding of all exposed dead-metal parts that might become energized by a single fault.

Exception: An appliance may be provided with a system of double insulation in accordance with the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097, in lieu of grounding.

38.1.2 An appliance marked as double insulated shall not be provided with a means for grounding and shall comply with the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097.

38.1.3 The means for grounding shall be:

a) A knockout or equivalent opening in the metal enclosure of an appliance intended to be permanently connected by a metal-enclosed wiring system;

b) An appliance grounding terminal or lead of an appliance intended to be permanently connected by a nonmetallic-enclosed wiring system (for example, nonmetallic-sheathed cable); or

c) An equipment-grounding conductor in the cord of a cord-connected appliance.

38.1.4 An equipment grounding conductor of a flexible cord shall be:

a) Finished to show a green color with or without one or more yellow stripes and

b) Connected to the grounding member of an attachment plug having a fixed grounding contact.

Exception: The grounding contact member of a grounding attachment plug used on the power supply cord of a portable hand-held, hand-guided, or hand-supported appliance may be of the moveable, self-restoring type on circuits operating at 150 volts or less between any conductor and ground.

38.1.5 The equipment grounding terminal or lead grounding point shall be connected to the frame or enclosure by a positive means, such as by a bolted or screwed connection. The grounding connection shall penetrate nonconductive coatings, such as paint or vitreous enamel. The grounding point shall be located so that it is unlikely that the grounding means will be removed during servicing not involving the grounding connection.

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38.1.6 The securing means specified in 38.1.5 shall be of corrosion-resistant metal, such as stainless steel, or shall be protected against corrosion in a manner that will not inhibit electrical conductivity between the screw and any other conductor. If a screw is used, a lock washer or an equivalent means shall be employed to prevent the screw from becoming loosened by vibration.

38.2 Bonding for grounding

38.2.1 If two or more appliances are electrically or mechanically connected to one another and one of them is grounded, each unit of the system that has a separate power-supply cord shall have a grounding conductor in the cord. If the appliances are interconnected electrically and one of them is grounded, they shall be bonded together (for example, by means of a discrete conductor included in an interconnecting cable). The size of the grounding conductor shall be at least the size of the supply conductors.

38.2.2 If a grounding means is provided on an appliance, all exposed dead-metal parts and all dead-metal parts within the enclosure that are exposed to contact during user servicing and that are likely to become energized shall be connected to the grounding means.

38.2.3 With reference to the requirements in 38.2.2, the following dead-metal parts are not considered likely to become energized:

a) A small metal part (such as an adhesive-attached foil marking, a screw, a handle, or similar part) that is:

1) On the exterior of the enclosure and separated from all electrical components by grounded metal or

2) Electrically isolated from all electrical components.

b) A panel or a cover that is isolated from all electrical components by a barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture-resistant insulating material not less than 1/32 inch (0.8 mm) thick.

c) A panel or a cover that does not enclose uninsulated live parts and is electrically isolated from other electrical components.

d) An isolated dead-metal part (such as a relay or contactor magnet frame and armature) that is not likely to come in contact with wiring and uninsulated live parts.

38.2.4 All conductive parts that are accessible to service personnel and that are usually expected to be at ground potential (resilient rubber-mounted motors, electronic chassis, and similar parts) and are likely to become energized by a single fault condition from a circuit involving risk of electric shock shall be connected to the grounding means, or a marking in accordance with 79.3.1 shall be provided.

38.2.5 Bonding shall be by a positive means such as by clamping, riveting, bolted or screwed connection, welding, or soldering and brazing materials having a softening or melting point higher than 454°C (850°F). The bonding connection shall penetrate nonconductive coatings such as paint or vitreous enamel.

38.2.6 If a bonding means depends on screw threads, two or more screws or a single screw that engages at least two full threads in metal shall be used.

38.3 Bonding conductor

38.3.1 Bonding shall be accomplished by a metal-to-metal contact of parts or by a separate bonding conductor as specified in 38.3.7 and 38.3.8.

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38.3.2 A bonding conductor shall be copper, copper alloy, aluminum, or other material that has been investigated for use as an electrical conductor.

38.3.3 Ferrous metal in the grounding path shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means.

38.3.4 Metal-to-metal hinge-bearing members for doors or covers are considered to be means for bonding the door or cover for grounding if a multiple bearing-pin type (piano-type) hinge is used.

38.3.5 A separate bonding conductor:

a) Shall be protected from mechanical damage or located within the outer enclosure and

b) Shall not be secured by a removable fastener used for a purpose in addition to bonding unless the bonding conductor is not likely to be omitted if the fastener is removed and replaced as intended.

A bonding conductor shall be in metal-to-metal contact with the parts to be bonded.

38.3.6 A splice shall not be employed in a bonding conductor.

38.3.7 Other than as specified in 36.2.1, in a cord-connected appliance, a bonding conductor shall have a cross-sectional area not less than that of the grounding conductor of the supply cord.

38.3.8 Other than as specified in 38.3.9 in a permanently-connected appliance, the size of a conductor employed to bond an electrical enclosure or a motor frame shall be based on the rating of the branch circuit overcurrent device to which the equipment will be connected. The size of the conductor shall be in accordance with Table 38.1.

Table 38.1
Minimum bonding conductor size

Maximum rating or setting of automatic overcurrent device in circuit, amperes[b]	Size of grounding/bonding conductor[a]			
	Copper wire,		Aluminum wire,	
	AWG	(mm^2)	AWG	(mm^2)
20	12	(3.3)	10	(5.3)
60	10	(5.3)	8	(8/4)

[a] A conductor with an equivalent cross-sectional area may be used.

[b] See 38.3.10.

38.3.9 A bonding conductor for a component or electrical enclosure is not required to be larger than the conductors supplying power to the component or components within the enclosure.

38.3.10 If more than one size of branch-circuit overcurrent-protective device is used, the size of a component-bonding conductor is to be based on the rating of an overcurrent-protective device providing ground-fault protection for that component. For a component individually protected by a branch circuit overcurrent-protective device rated less than the overcurrent-protective device used in the power-supply circuit, a bonding conductor is to be sized on the basis of the component overcurrent-protective device rating.

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39 Motors

39.1 Construction

39.1.1 A motor provided as part of an appliance shall be capable of handling the load it is intended to drive without introducing a risk of fire, electric shock, or injury to persons.

39.1.2 A motor winding shall be such as to resist the absorption of moisture.

39.1.3 With reference to the requirement in 39.1.2, film-coated wire is not required to be additionally treated to prevent absorption of moisture, but fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials shall be provided with impregnation or otherwise treated to prevent moisture absorption.

39.1.4 A brush cap accessible from outside the enclosure of a portable appliance that prevents contact with a live part at a potential of more than 30 volts (42.4 volts peak) to any other part or to ground shall be fastened in place so that removal cannot be accomplished by an ordinary tool used in the intended manner.

39.2 Brush wear out

39.2.1 A brush-holder assembly shall be constructed so that when a brush is worn out (no longer capable of performing its function), the brush, spring, and other parts of the assembly will be retained to the degree necessary to reduce the risk of:

a) Accessible dead-metal parts becoming energized and

b) Live parts becoming accessible.

39.2.2 With reference to the requirement in 39.2.1, the parts of a brush holder assembly are considered to be acceptably retained if:

a) The motor is enclosed, independently of the appliance enclosure, to the degree that the brush, spring, or other parts of the assembly will be contained within the motor enclosure, and no conductive parts of the motor enclosure are accessible to contact; or

b) The appliance has spacings such that parts of the brush holder assembly which can become free to move will not become live and accessible to contact nor bridge live parts to accessible metal parts, and the motor enclosure is not accessible to contact; or

c) Other constructions equivalent to (a) or (b).

39.3 Overload protection

39.3.1 An appliance shall incorporate thermal or overload protection in accordance with 39.3.2 if it is intended to be:

a) Permanently-connected, continuous-duty, and manually started, employing a motor rated 1 horsepower (746 watts output) or less or

b) Remotely or automatically controlled.

39.3.2 Motor-overload protection required for an appliance shall consist of one of the following:

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a) Thermal protection complying with the applicable requirements in the Standard for Thermally Protected Motors, UL 1004-3. Electronically protected motors shall comply with the Standard for Electronically Protected Motors, UL 1004-7. See 39.3.10.

Exception No. 1: For an appliance that includes a control that positively and reliably limits the length of time the appliance can operate, the duration of the temperature test and the endurance test, both under locked-rotor conditions, may be less than that specified but shall be not less than the time the appliance can operate.

Exception No. 2: A motor intended to move air only by means of an air-moving fan that is integrally attached, keyed, or otherwise fixed to the motor shaft is not required to have running-overload protection.

b) Impedance protection complying with the applicable requirements in Standard for Impedance Protected Motors, UL 1004-2, when the motor is tested as used in the appliance under stalled-rotor conditions;

c) Other protection that is shown by test to be equivalent to the protection mentioned in (a).

Exception: A motor as described in Exception No. 2 to (a) is not required to have running-overload protection.

39.3.3 Motor-overload protection provided for an appliance not required to have such protection shall:

a) Comply with the requirements in 39.3.2 or

b) Be shown by test not to result in a risk of fire, electric shock, or injury to persons.

39.3.4 The motor of an appliance with load characteristics likely to result in an overload or stalled condition that will not be evident to the user shall incorporate thermal or overload protection in accordance with the requirements in 39.3.2.

Exception: Motors indicated below are not required to comply with the overload protection requirement:

a) Motors rated less than 1 horsepower and:

1) Which are manually started;

2) Where the operator is in attendance during the entire operating cycle; and

3) Where malfunction of the motor is evident.

39.3.5 A multispeed motor in an appliance as specified in 39.3.1 which is provided with a separate overload protective device to provide running overload protection shall have the protection at all speeds at which the motor is intended to operate.

39.3.6 Overload devices employed for running overload protection, other than those that are inherent in a motor, shall be located in at least one ungrounded conductor of a single-phase supply system and in each ungrounded conductor of a 3-phase supply system.

39.3.7 If a requirement in this standard refers to the horsepower rating of a motor and the motor is not rated in horsepower, the appropriate table in the National Electrical Code, ANSI/NFPA 70, is to be used to determine the relationships between horsepower and full-load currents for motors. For a universal motor, the table applying to a single-phase, alternating-current motor is to be used if the appliance is marked for use on alternating current only; otherwise the table applying to direct-current motors is to be used.

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39.3.8 Motor-overload protection in which contacts control a relay coil in a motor starter shall comply with the requirements of 39.3.1.

39.3.9 Fuses used in motor-overload-protective devices shall be configured so that the motor is investigated with the largest size of fuse that is capable of being inserted in the fuseholder.

39.3.10 Electronically protected motor circuits shall comply with one of the following:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991. When the protective electronic circuit is relying upon software as a protective component, it shall comply with the requirements in the Standard for Software in Programmable Components, UL 1998. If software is relied upon to perform a safety function, it shall be considered software Class 1;

b) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1. If software is relied upon to perform a safety function, it shall be considered software Class B; or

c) Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1.

Exception: Compliance with the above standards is not required for an electronically protected motor circuit if there is no risk of fire, electric shock, or injury to persons during abnormal testing with the motor electronic circuit rendered ineffective; compliance with the applicable requirements of this standard is then required.

39.4 Insulation systems

39.4.1 Class A insulation systems shall consist of a combination of magnet wire and major component insulation materials evaluated and found to operate as intended in its end use. Thermoset materials and materials in Table 39.1 at the thicknesses specified are permitted to be used without further evaluation.

Table 39.1
Primary Class A insulating materials and minimum thicknesses

Material	Minimum thickness	
	Inch	(mm)
Vulcanized fiber	0.028	(0.71)
Polyethylene terephthalate film	0.007	(0.018)
Cambric	0.028	(0.71)
Treated cloth	0.028	(0.71)
Electrical grade paper	0.028	(0.71)
Mica	0.006	(0.15)
Aramid paper	0.010	(0.25)

39.4.2 For Class A insulation systems employing other materials or thinner materials than those indicated in Table 39.1 or a combination of materials, the materials, whether polymeric or not polymeric (treated cloth, for example), shall comply with the requirements in 39.4.3.

39.4.3 A polymeric material employed in a Class 105 (A) insulation system that isolates the windings from dead metal parts shall be:

a) Unfilled or glass-reinforced nylon;

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b) Polycarbonate;

c) Polybutylene terephthalate;

d) Polyethylene terephthalate;

e) Phenolic; or

f) Acetal

and shall have a relative or generic thermal index for electrical properties of 105°C (221°F) minimum. Leads shall be rated 90°C (194°F) minimum.

Exception No. 1: Other polymeric materials used in a Class 105 (A) insulation system shall comply with the requirements for thermal aging in 72.4.

Exception No. 2: Class (105) A DC motor located in limited energy primary circuit (See 4.36) or Class 2 circuit, shall comply with the applicable requirements in this standard.

39.4.4 Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with the Standard for Systems of Insulating Materials – General, UL 1446.

39.4.5 All insulation systems employing integral ground insulation shall comply with the requirements specified in the Standard for Systems of Insulating Materials – General, UL 1446

Exception: Class (105) A DC motor located in limited energy primary circuit (See 4.36) or Class 2 circuit, shall comply with the applicable requirements in this standard.

PERFORMANCE

40 General

40.1 The tests described in Sections 42 – 47 are to be conducted in that order, on the same samples.

Exception: Some tests on hand-supported hair dryers will require more than one sample, as noted in the description of the individual tests.

40.2 Unless otherwise noted in the individual requirements, all tests are to be conducted with the appliance connected to a supply circuit of rated frequency, and having a potential of:

a) 120 volts, for an appliance rated from 110 volts – 120 volts, inclusive;

b) 240 volts, for an appliance rated from 220 volts – 240 volts, inclusive; and

c) The maximum rated voltage of the appliance, for an appliance other than as mentioned in (a) or (b).

40.3 An appliance having a single frequency rating is to be tested at that frequency. An appliance rated AC/DC or 60 Hz/DC is to be tested on direct current or 60-Hz alternating current, whichever results in the most severe condition. An appliance rated 25 – 60 Hz or 50 – 60 Hz is to be tested on 60-Hz alternating current.

40.4 A simulated head used for temperature testing is to consist of a foamed plastic wig form, approximately 21-1/2 inches (546 mm) in circumference, closely wrapped with two layers of cheesecloth.

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Pieces of black (exposed and developed) cellulose acetate, photographic film to represent hair-holding devices are to be attached to the top and sides.

40.5 Wherever cheesecloth is mentioned in connection with either a temperature test or an abnormal test, the cloth is to be bleached cheesecloth 36 inches (914 mm) wide, running 14 – 15 yards per pound mass (approximately 28 – 30 m^2/kg mass), and having what is known in the trade as a "count of 32 × 28," which means that for any square inch there are 32 threads in one direction and 28 threads in the other direction (for any square centimeter there are 13 threads in one direction and 11 threads in the other direction).

40.6 Wherever a hardwood surface is specified in connection with a test, the hardwood surface is to consist of a layer of tongue-and-groove oak flooring mounted on two layers of nominal 3/4 inch (19.1 mm) plywood. The oak flooring is to be nominally 3/4 inch thick [actual size 3/4 inch by 2-1/4 inch (19.1 mm by 57.2 mm)]. The assembly is to rest on a concrete floor or an equivalent nonresilient floor during the test.

41 Ionization Circuits

41.1 Grooming appliances which employ ionization technology shall comply with 40.2 and 40.3.

41.2 The high voltage power supply used in the ionizer shall be evaluated to the applicable construction and component requirements for power supplies contained in the Standard for Electrostatic Air Cleaners, UL 867. The following performance tests of UL 867 shall be considered:

a) Output Test;

b) Temperature Test;

c) Dielectric Voltage Withstand Test – High Voltage Transformer Core;

d) Dielectric Voltage Withstand Test – Induced Energy, (for linear-type transformer only);

e) Abnormal Operations Test – Component Short- And Open-Circuit Test, and;

f) High Voltage Insulating Materials Arcing Test.

41.3 The high voltage pins (electrodes) of ionizer shall not be accessible per 9.4.

41.4 A grooming appliance employing ionization circuitry shall not produce a concentration of ozone exceeding 0.05 parts per million by volume when tested as described in 74.2 – 74.7.

42 Leakage Current Test

42.1 The leakage current of a cord-connected appliance rated for a nominal 250-volt or less supply when tested in accordance with 42.3 – 42.8 shall be not more than:

a) 0.5 milliampere for an ungrounded 2-wire appliance,

b) 0.5 milliampere for a grounded 3-wire portable appliance, and

c) 0.75 milliampere for a grounded 3-wire appliance:

1) Employing a standard attachment plug rated 20 amperes or less and

2) Intended to be fastened in place or located in a dedicated space.

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42.2 Leakage current refers to all currents, including capacitively coupled currents that may be conveyed between exposed conductive surfaces of an appliance and ground or other exposed conductive surfaces of an appliance.

42.3 All exposed conductive surfaces are to be tested for leakage current. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure that reduces the risk of electric shock as described in 9.4.1 – 9.4.8. Surfaces are considered to be simultaneously accessible when they can be readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages considered not to present a risk of electric shock.

42.4 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil having an area of 10 by 20 centimeters in contact with the surface. Where the surface is less than 10 by 20 centimeters, the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the appliance.

42.5 The measurement circuit for leakage current is to be as shown in Figure 42.1. The measurement instrument is described in (a) – (c). The meter actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used is not required to have all the attributes of the defined instrument.

a) The meter is to have an input impedance of a 1500-ohm resistor shunted by a capacitance of 0.15 microfarad.

b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of the voltage across the resistor or current through the resistor.

c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response (ratio of indicated-to-actual value of current) equal to the ratio of the impedance of a 1500-ohm resistor shunted by a 0.15 microfarad capacitor to 1500 ohms. At an indication of 0.5 or 0.75 milliampere, the measurement is to have an error of not more than 5 percent at 60 hertz.

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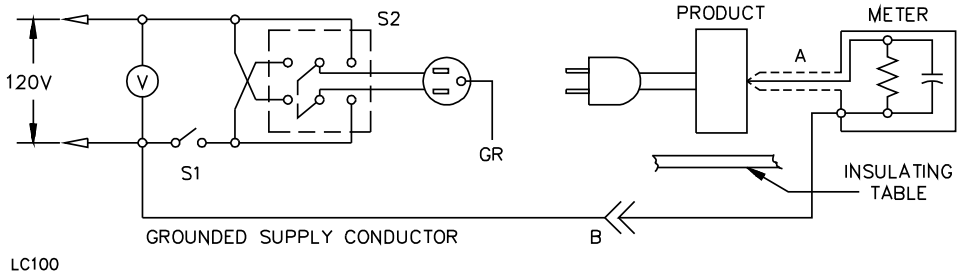
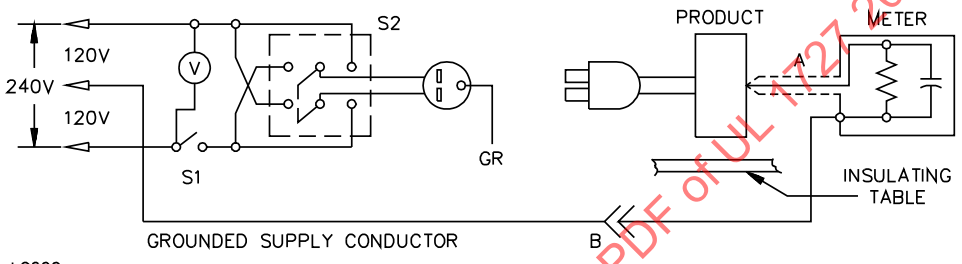
Figure 42.1

Leakage current measurement circuits



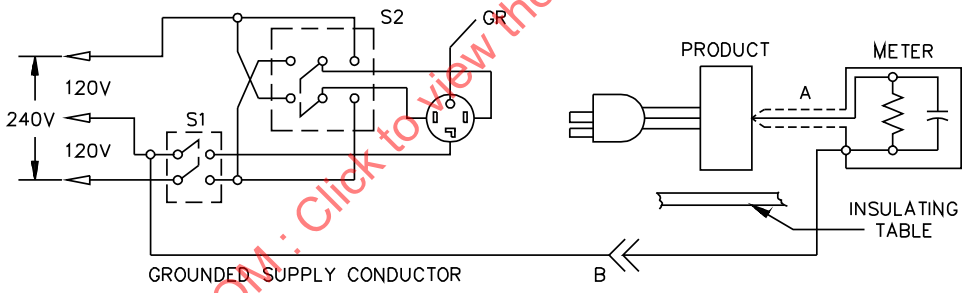
LC100

Appliance intended for connection to a 120-volt power supply.



LC200

Appliance intended for connection to a 3-wire, grounded-neutral power supply, as illustrated above.



LC300

Appliance intended for connection to a 3-wire, grounded-neutral power supply, as illustrated above.

A – Probe with a shielded lead.

B – Separated and used as a clip when measuring currents from one part of an appliance to another.

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42.6 Unless the meter is being used to measure leakage from one part of an appliance to another, the meter is to be connected between an accessible part and the grounded supply conductor.

42.7 A sample of the appliance is to be tested for leakage current starting with the as received condition, but with its grounding conductor, if any, open at the attachment plug (open at receptacle as shown in Figure 42.1). The as received condition is without prior energization, other than that which may have occurred as part of the production-line testing. The supply voltage is to be adjusted to 120 or 240 volts, depending on the rating. Thermostats are to be closed. The test sequence, with reference to the measurement circuit (Figure 42.1), is to be as follows:

a) With switch S1 open, the appliance is to be connected to the measurement circuit. Leakage current is to be measured using both positions of switch S2, and with the appliance switching devices in all their operating positions.

b) Switch S1 is then to be closed, energizing the appliance, and within 5 seconds, the leakage current is to be measured using both positions of switch S2 and with the appliance operated at the maximum heat setting of controls.

c) Leakage current is to be monitored until thermal stabilization under the maximum heat conditions occurs. Both positions of switch S2 are to be used. The equivalent of thermal stabilization is considered to be obtained as in the normal temperature test. If any temperature-regulating thermostat does not cycle at the maximum setting, the setting is to be lowered until the thermostat does cycle before the final measurements at thermal stabilization are taken. Measurements are to be made with the thermostat, if any, open and closed. Upon evidence of stabilizing readings, monitoring periods may be increased.

d) If the appliance employs a single-pole switch or a thermostat with an off position, monitoring of leakage current is to continue until the leakage current stabilizes or decreases after the appliance is turned off. Both positions of switch S2 are to be used.

42.8 Normally a sample will be carried through the complete leakage current test program as covered in 42.7, without interruption for other tests. With the concurrence of those concerned, the leakage current test may be interrupted for the purpose of conducting other nondestructive tests.

43 Operational Test

43.1 Operation of an appliance as described in 43.2, shall not increase the risk of fire, electric shock, or injury to persons.

43.2 With reference to 43.1, an as-received sample of the appliance is to be set up or installed in accordance with the manufacturer's instructions. The sample is to be operated, in accordance with the manufacturer's instructions, with respect to the intended uses of the appliance, including maintenance and cleaning recommended by the manufacturer and lack of such maintenance and cleaning; and with all accessories recommended by the manufacturer for use with the appliance. The appliance is to be manipulated as it would be in actual use, including manipulation of all controls and operation under the various loading conditions that can be expected. The appliance is to be operated for a sufficient length of time or through a sufficient number of cycles so that all reasonably foreseeable complications are revealed.

44 Starting Current Test

44.1 A motor-operated appliance shall start and continue to operate on a test circuit protected by a nontime-delay fuse that has a current rating corresponding to that of the branch circuit to which the appliance is intended to be connected. The performance is unacceptable if the fuse opens the circuit.

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Exception: A time-delay fuse may be used if all of the following conditions are met:

a) The construction of the product or its intended use is such that it is likely to be used only on the same branch circuit after installation;

b) The appliance will start and continue to operate on a circuit protected by a time-delay fuse; and

c) The appliance is marked in accordance with 79.5.1.

44.2 In a test to determine whether an appliance complies with the requirement in 44.1, the appliance is to be started three times, with the appliance at room temperature at the beginning of the test. Each start of the motor is to be made under conditions representing the beginning of normal operation (the beginning of the normal operating cycle, in the case of an automatic appliance) and the motor is to be allowed to come to rest between successive starts.

45 Power Input Test

45.1 The current or power input to an appliance rated 50 watts or less shall be within the inclusive range of 75 – 110 percent of that rating. If the marked rating is greater than 50 watts, the current or power input shall be within the inclusive range of 90 – 110 percent of the rating.

45.2 The current or power input to the appliance is to be measured with the appliance at intended operating temperature under full-load conditions, and while connected to a circuit of a voltage in accordance with 40.2. Control switches or the equivalent, if provided, are to be set to give the maximum power input.

Exception: The current or power input of an appliance that uses a positive temperature coefficient (PTC) heating element shall be measured 1 minute after it has become energized.

46 Temperature Test

46.1 General

46.1.1 An appliance, when tested under the conditions described in 46.1.18 – 46.1.25, shall not attain a temperature at any point sufficiently high to constitute a risk of fire or to damage any of the materials employed in the appliance, or show maximum temperatures at specific points greater than those indicated in Table 46.1 and Table 46.2.

Exception: An initial temperature transient on a cycling, thermostatically-controlled appliance may be in excess of the values shown in Table 46.1 for such materials as molded phenolic, when the duration and extent of the excursion do not:

a) Result in performance that may have a damaging effect and

b) Unduly shorten the life of the appliance.

The maximum temperature transient permitted shall not exceed the temperature that is representative of the temperature used to investigate the material involved.

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Table 46.1
Maximum temperatures

Materials and component parts	°C	(°F)
A. MOTORS		
1. Class 105 insulation system on coil windings of an AC motor having a frame diameter[a] of more than 7 inches (178 mm), of a DC motor, and of a universal motor:		
a. In an open motor:		
Thermocouple method[b]	90	(194)
Resistance method[b]	100	(212)
b. In a totally enclosed motor:		
Thermocouple method[b]	95	(201)
Resistance method[b]	105	(221)
2. Class 105 insulation systems on coil windings of an AC motor having a frame diameter[a] of more than 7 inches (178 mm), or less, not including a universal motor:		
a. In an open motor (thermocouple or resistance method)[b]	100	(212)
b. In a totally enclosed motor (thermocouple or resistance method)[b]	105	(221)
3. Class 130 insulation systems on coil windings of an AC motor having a frame diameter[a] of more than 7 inches (178 mm), of a DC motor, and a universal motor:		
a. In an open motor:		
Thermocouple method[b]	110	(230)
Resistance method[b]	120	(248)
b. In a totally enclosed motor:		
Thermocouple method[b]	115	(239)
Resistance method[b]	125	(257)
4. Class 130 insulation systems on coil windings of an AC motor having a frame diameter[a] of 7 inches (178 mm) or less, not including a universal motor:		
a. In an open motor:		
Thermocouple or resistance method[b]	120	(248)
b. In a totally enclosed motor:		
Thermocouple or resistance method[b]	125	(257)
B. COMPONENTS		
1. Class 130 insulation systems except as indicated in subitems (3) and (4) to item (A) and subitem (2) to item (B):		
Thermocouple method	110	(230)
Resistance method	120	(248)
2. Class 130 insulation systems on vibrator coils:		
Thermocouple or resistance method	120	(248)
3. Class 105 insulation systems on windings of a relay, a solenoid, or a transformer:		
Thermocouple method	90	(194)
Resistance method	110	(230)
4. Class 105 insulation systems on vibrator coils:		
Thermocouple or resistance method	100	(212)
5. Sealing compounds:	c	c
6. Capacitors:		
a. Electrolytic[d]	65	(149)

Table 46.1 Continued on Next Page

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Table 46.1 Continued

Materials and component parts	°C	(°F)
b. Other types[e]	90	(194)
7. Fuses[f]	90	(194)
8. Flatiron or appliance plugs[f]	200	(392)
9. Black cellulose acetate photographic film (see 40.4)	110	(230)
C. CONDUCTORS		
1. Rubber- or thermoplastic-insulated wires and cords[f]	60	(140)
2. Type HPN flexible cord	90	(194)
3. Copper or copper-base alloy conductors:		
a. Tinned or bare having:		
i. A diameter or thickness less than 0.015 inch (0.38 mm)	150	(302)
ii. A diameter or thickness 0.015 inch (0.38 mm) or more	200	(392)
b. Plated with nickel, silver, gold, or a combination of these metals	258	(482)
D. ELECTRICAL INSULATION – GENERAL		
1. Varnished cloth insulation	85	(185)
2. Fiber employed as electrical insulation	90	(194)
3. Phenolic composition (other than in a flatiron or appliance plug) employed as electrical insulation or as a part[f]	150	(302)
4. Glass fiber sleeving:		
a. Unimpregnated[g,h]	250	(482)
b. Coated[g,h]	Not less than its temperature rating	
E. GENERAL		
1. Wood or other combustible material	90	(194)
2. A surface supporting a portable appliance	150	(302)
3. A surface upon which a stationary or a fixed appliance may be placed or mounted in service, and surfaces that may be adjacent to the appliance when so placed or mounted	90	(194)
4. At any point within a terminal box or wiring compartment of a permanently-connected appliance in which power supply conductors are to be connected, including such conductors themselves, unless the appliance is marked in accordance with 79.2.1	60	(140)
5. For a direct plug-in appliance, surface of receptacle, receptacle coverplate, and surrounding wall surfaces	90	(194)

[a] This is the diameter measured in the plane of the laminations of the circle circumscribing the stator frame, excluding lugs, boxes, and the like, used solely for motor mounting, assembly, or connection.

[b] See 46.1.9, 46.1.11, and 46.1.16.

[c] Except in the case of a thermosetting material, the maximum sealing compound temperature, when corrected to a 25°C (77°F) ambient temperature, is 15°C (27°F) less than the softening point of the compound as determined in the Standard Test Methods for Softening Point by Ring-and-Ball Apparatus, ASTM E28.

[d] For an electrolytic capacitor that is physically integral with or attached to a motor, the maximum temperature on insulating material integral with the capacitor enclosure may be no more than 90°C (194°F).

[e] A capacitor that operates at a maximum temperature of more than 90°C (194°F) may be judged on the basis of its marked temperature limit.

[f] The limitations do not apply to compounds and components that have been investigated for use at higher temperatures.

[g] A higher temperature rise is acceptable provided the appliance complies with the Extended Operation Test, Section 70.

[h] This requirement does not apply to sleeving installed where it is not folded nor subjected to compression or sharp bends.

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Table 46.2
Maximum temperatures of appliance surfaces that may be contacted by the user

Surface function and material[a]	°C	(°F)
1. A part of the appliance that is intended to be grasped for lifting, carrying, or holding the appliance		
A. Metal[b]	55	(131)
B. Porcelain or vitreous material	65	(149)
C. Molded material – rubber or wood	75	(167)
2. A handle or knob that is contacted but does not involve lifting, carrying, or holding the appliance and any other surface subject to contact during operation or user maintenance		
A. Metal[b]	60	(140)
B. Porcelain or vitreous material	70	(158)
C. Molded material – rubber or wood	85	(185)
3. A surface other than a heating-function surface that is known to be hot due to its proximity to the heating function surface, and the enclosure surface of a hair dryer spaced more than 1/2 inch (12.7 mm) from the outermost perimeter of the heated-air outlet		
A. Metal	70	(158)
B. Other than metal	95	(203)

[a] A handle, knob, or similar part made of a material other than metal that is plated or clad with metal having a thickness of 0.005 inch (0.127 mm) or less is considered to be and is judged as a nonmetallic part.

[b] If the maximum temperature on a rivet or screw in a barrier or handle, which would be touched in an intended gripping or lifting action, exceeds the values given, it is to be recessed at least one-half the diameter of the hole, and the hole shall not be larger than 3/8 inch (9.5 mm) in diameter.

46.1.2 The temperatures specified in Table 46.1 and Table 46.2 are based on an assumed ambient temperature of 25°C (77°F). A test may be conducted at an ambient temperature within the range of 10 – 40°C (50 – 104°F).

46.1.3 During a test conducted at an ambient temperature of 25°C (77°F), an observed temperature shall not exceed the values specified in Table 46.1 and Table 46.2.

46.1.4 If a test is conducted at an ambient temperature other than 25°C (77°F), an observed temperature other than as mentioned in 46.1.5 shall be corrected as described in 46.1.6. Neither a corrected temperature nor an observed temperature as mentioned in 46.1.5 shall exceed the values specified in Table 46.1 and Table 46.2.

46.1.5 An observed temperature limited by an automatic temperature control or by a process such as the boiling of water or the introduction of a liquid at a fixed temperature is not to be corrected.

46.1.6 An observed temperature is to be corrected by addition, if the ambient temperature is lower than 25°C, or be subtraction, if the ambient temperature is higher than 25°C, of the difference between 25°C (77°F) and the ambient temperature.

46.1.7 If a corrected temperature exceeds the values specified in Table 46.1 or Table 46.2, the test may be repeated, at the request of the manufacturer, at an ambient temperature closer to 25°C (77°F).

46.1.8 If an appliance is provided with a temperature-regulating control that, under intended operating conditions, except motor slowdown test, is relied upon to maintain temperatures within the limits specified in Table 46.1 and Table 46.2 only, the control shall comply with the requirements in 66.2.1 for temperature-regulating control.

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46.1.8A Temperature control for hand-supported hair dryers relied upon to maintain temperatures within the limits specified in Table 46.1 and Table 46.2 during motor slowdown test in 46.3 and abnormal tests, shall comply with the requirements in 66.2.1 for temperature control for hand-supported hair dryers. See 4.47 and 32.2.2.

46.1.9 The temperature of a coil or winding is to be measured by means of thermocouples mounted on the outside of the coil wrap. If the coil is inaccessible for mounting thermocouples (for example, a coil immersed in sealing compound), or the coil wrap includes thermal insulation such as asbestos (or more than 1/32 inch (0.8 mm) of cotton, paper, rayon, or similar insulation), the change of resistance method is to be used. For the thermocouple-measured temperature of a coil of an AC motor (other than a universal motor) having a frame diameter 7 inches (178 mm) or less [subitems (2) and (4) to item A of Table 46.1], the thermocouple is to be mounted on the integrally applied insulation of the conductor.

46.1.10 In using the resistance method, the windings are to be at room temperature at the start of the test. The temperature of a winding is to be calculated from the formula:

$$T = \frac{R}{r}(k + t) - k$$

in which:

T is the final temperature, in °C;

R is the resistance of the coil at the end of the test, in ohms;

r is the resistance of the coil at the beginning of the test, in ohms;

k is 234.5 for copper, 225.0 for electrical conductor grade (EC) aluminum [values of the constant (k) for other grades must be determined]; and

t is the room temperature at the beginning of the test, in °C.

46.1.11 At a point on the surface of a coil where the temperature is affected by an external source of heat, the maximum temperature measured by means of a thermocouple may be higher than the maximum indicated in Table 46.1 as specified in the following table, when the maximum temperature of the coil as measured by the resistance method is not more than that specified in Table 46.1.

Reference in Table 46.1	Maximum temperature, °C	(°F)
Subitem (1)(2) to item (A)	105	(221)
Subitem (2)(2) to item (A)	105	(221)
Subitem (3)(2) to item (A)	130	(325)
Subitem (4)(2) to item (A)	130	(325)
Subitem (2) to item (B)	130	(325)
Subitem (3) to item (B)	105	(221)
Subitem (4) to item (A)	105	(221)

46.1.12 With respect to 46.1.11, if the maximum temperature of the coil wrap is not exceeded due to radiation from an external source of heat, the temperature of the coil may be measured by means of a thermocouple on the integral insulation of the coil conductors.

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46.1.13 If the retention of the asbestos insulation of a heater cord depends upon a fabric braid, the braid shall not be removed nor subjected to a maximum temperature of more than 90°C (194°F) unless other means are provided to hold the asbestos in place. The jacket of Type HSJ or Type HSJO cord shall not be subjected to a maximum temperature of more than 60°C (140°F) if the protection afforded by the jacket is required.

46.1.14 Certain special treatments, such as the use of an impregnant, are acceptable for retaining the asbestos around the conductors of a heater cord at elevated temperatures.

46.1.15 Stainless steel and other corrosion-resistant alloys may be used for current-carrying parts without temperature restrictions. Plated iron or steel may be used for current carrying parts where the material is subjected to a maximum temperature of more than 100°C (212°F), but plain (unplated) iron or steel may not be used, regardless of temperature.

46.1.16 Temperature readings are to be obtained by means of thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). The temperature is considered to be constant when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5 minute intervals, indicate no change.

Exception: At coils, the preferred method of measuring temperatures is the thermocouple method; temperature measurements by either the thermocouple or resistance method may be used, but the thermocouple method is not to be employed for a temperature measurement at any point where supplementary heat insulation is employed.

46.1.17 When thermocouples are used in the determination of temperatures in connection with heating of electrical equipment, it is common practice to use thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires and a temperature indicating instrument. Thermocouples consisting of 30 AWG iron and constantan wires and a potentiometer-type temperature indicating instrument are to be used whenever referee temperature measurements by thermocouples are required.

46.1.18 To determine whether an appliance complies with the requirement in 46.1.1, it is to be operated while connected to a supply circuit as described in 40.2.

46.1.19 For an appliance provided with a heating element, unless a particular voltage or other test condition is specified in 46.1.1 – 46.1.18 and 46.1.20 – 46.1.25, the test voltage specified in 40.2 is to be increased, if necessary, to cause the wattage input to the appliance to be equal to its marked wattage rating.

46.1.20 If an appliance employs a motor in addition to a heating element, the voltage applied to an integrally connected motor is to be not higher than the test voltage as specified in 40.2. A motor supplied from a separate circuit is to be operated at a voltage (depending upon the motor rating) as specified for an integrally connected motor.

46.1.21 During the test, each general-use receptacle or a general-use receptacle intended for a limited current load shall be loaded with a 15-ampere resistive load or with a lesser load if marked in accordance with 79.1.5.

Exception: Each outlet of a duplex receptacle shall be loaded with a 10-ampere load.

46.1.22 The appliance is to be mounted or supported as in service and tested under conditions approximating those of intended operation. Installation against a wall, in a right angle corner of a room, or in an alcove is to be simulated if the appliance lends itself to such placement and if such placement results in restricted ventilation. Walls are to be formed by black painted vertical sheets of plywood not less than 3/8 inch (9.53 mm) thick and having such width and height that they extend not less than 2 feet (0.61 m)

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beyond the physical limits of the appliance. If a timer switch or the equivalent is provided as part of the appliance, an appropriate cycle of operation shall be used.

Exception: For requirements regarding hand-supported hair dryers, see 50.3.9.1.

46.1.23 In an appliance provided with a temperature-limiting control (see Table 66.1) or with a motor having a thermal protective device, there shall not be operation of that control or protective device during the temperature test.

46.1.24 In a hand-supported hair dryer, the motor circuit shall not become de-energized during the temperature test.

46.1.25 If the appliance includes a means for adjusting the operating temperature, this control is to be set to provide maximum heating.

46.2 Hair dryers

46.2.1 General

46.2.1.1 For a floor- or table-supported hair dryer having a bonnet or rigid hood and provided with an adjustable temperature control, temperatures are to be recorded after 15 minutes of operation with the control set for maximum heating and with the dummy head in the position normally occupied by the human head under the dryer. The control is then to be set for the coolest condition that results in an average temperature not less than 43°C (109°F) on the top and sides of the dummy head, and operation is to be continued until all temperatures have become constant. The dummy head is then to be removed, the control is to be reset for maximum, and operation is to be continued until temperatures have become constant. A hair dryer that has a flexible air tube that can be separated from the bonnet or rigid hood is also to be tested under the conditions described in 46.2.2.1.

46.2.1.2 For a hair dryer that is provided with a rigid hood, the dummy head is to be so located that its surface will be a minimum of 1 inch (25.4 mm) from the interior surface of the hood and so positioned in the hood that maximum temperatures will result.

46.2.1.3 A floor-supported hair dryer not provided with an adjustable temperature control is to be operated continuously (with the dummy head in place) until all temperatures have become constant.

46.2.2 Hand-supported hair dryers

46.2.2.1 A hand-supported hair dryer is to be tested with the adjustable temperature control, if any, set for the most severe condition of use, and the hair dryer operated continuously until stabilized conditions are achieved. During this operating time the hair dryer is to be supported in the position representing the most severe conditions of use, first without any attachment on the heated-air outlet nozzle, and then, if the hair dryer is provided with one or more attachments for the heated-air outlet, in turn with each attachment in place, as intended. During each of these tests, the plane of the thermocouple grid specified in 46.2.2.2 is to be positioned 1 inch (25.4 mm) from the plane of the heated-air outlet of:

a) The dryer nozzle or

b) The attachment nozzle.

The center of the air stream is to be directed at the center of the grid. Temperatures are to be measured throughout the test. A maximum temperature greater than the limits specified in Table 46.1 and Table 46.2, or greater than 125°C (257°F) for the average of the five highest thermocouple readings on the grid described in 46.2.2.2, is not acceptable.

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46.2.2.2 The thermocouple grid assembly is to consist of two pieces of 1/16 inch (1.6 mm) thick glass epoxy board of the configuration and dimensions shown in Figure 46.1. The two boards are to be separated 1/8 inch (3.2 mm) by one 5 1/4 by 1/4 by 1/8 inch (133.3 by 6.4 by 3.2 mm) wood spacer at top and bottom edges. Each spacer is to be secured by four 4-40 by 3/8 inch (9.5 mm) countersunk flat head machine screws. Each end screw shall be threaded from the face of the assembly into a nut against the rear epoxy board. Each of the middle screws is to be located approximately 1-1/2 inches (38.1 mm) from the nearest longer edge of the board and thread from the face into a stand-off leg of a sheet aluminum back plate. The 5-1/2 by 3-1/4 inch (140 by 82.6 mm) stand-off back plate is to consist of sheet aluminum with a minimum thickness of 0.05 inch (1.3 mm) and having a minimum 7/16-inch (11.1-mm) wide, integral stand-off leg formed at each corner by means of an extension of the metal being bent in two successive 90-degree angles to cause the back plate to stand away from the rear epoxy board a distance of 1/4 inch. The back is to be secured to the center 5-1/2 by 3-1/4 inch section of the board. The board assembly is to be provided with fifty-three 30 AWG (0.05 mm^2) thermocouples. The thermocouples are to be located on the grid spaced as shown in Figure 46.1. The thermocouples are to be passed through the two thicknesses of glass epoxy board, and the thermocouple junction is to be cemented to the face of the board using epoxy cement, as shown in Figure 46.2.

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Figure 46.1

Spacings on thermocouple grid

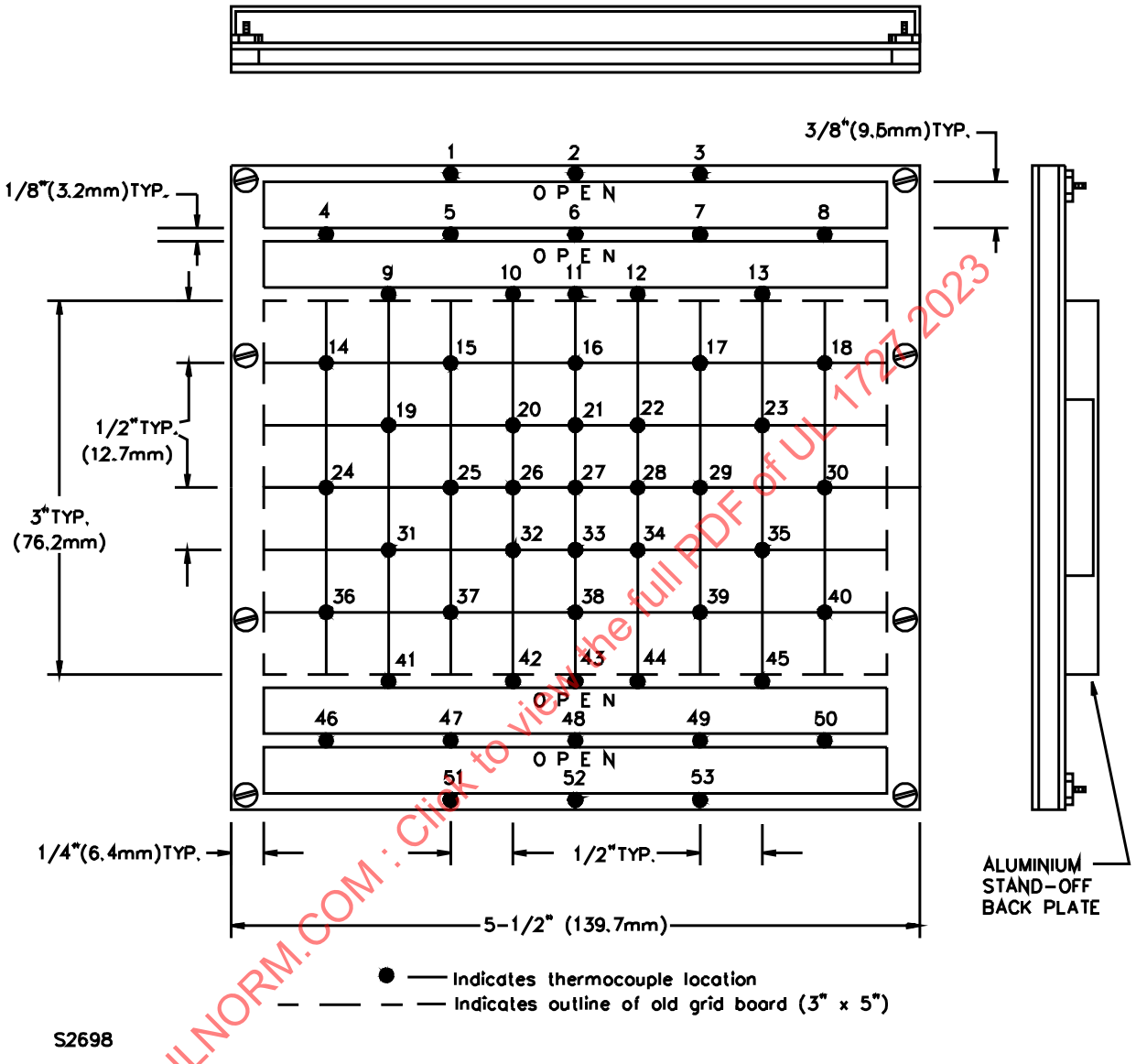

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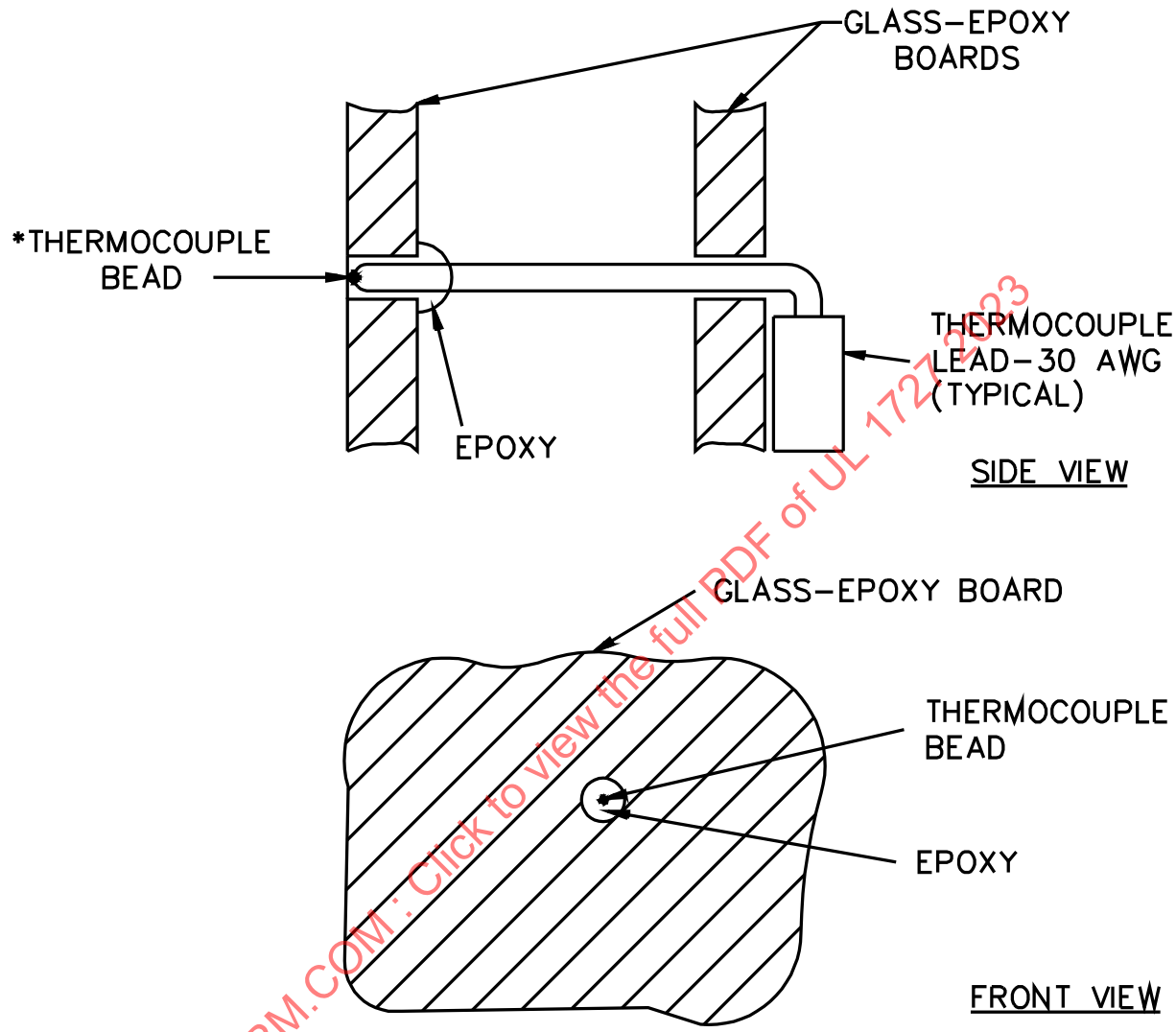
Figure 46.2

Installation of thermocouple junction in glass-epoxy board



* TIP OF BEAD EXPOSED AT OUTER SURFACE OF BOARD BY SANDING AWAY EPOXY AFTER ASSEMBLY. BEAD NOT NECESSARILY CENTERED IN HOLE.

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46.3 Motor slowdown test method

46.3.1 A hand-supported hair dryer that is to be subjected to the test described in 46.3.3 – 46.4.2 is to have the heater and motor circuits separated, with leads to the motor brought outside the appliance and connected to a separate variable supply source so that the motor speed can be varied with negligible effect on the heater circuit. For an appliance incorporating a motor load connected in the heating element circuitry, such as a low-voltage direct-current motor, a motor identical to the motor in the appliance ("dummy" motor load) is to be electrically connected to replace the motor in the appliance.

46.3.2 If the unit is provided with a temperature regulating control, that control is to be shorted out during the test.

46.3.3 The power input to an appliance tested with a dummy motor load is to be adjusted to 110 percent of the rated appliance wattage. The power input to an appliance tested without a dummy motor load is to be adjusted to 110 percent of the rated appliance wattage minus the wattage input measured to the motor alone at rated motor voltage (120 or 240 volts). The voltage to the internal appliance motor is to be adjusted so as to obtain a motor speed equal to that observed with the appliance operated at rated voltage (120 or 240 volts) and the internal motor electrically connected in the appliance as intended.

46.3.4 After the appliance reaches constant temperatures under the operating conditions described in 46.3.1 – 46.3.3, the voltage to the internal motor is to be reduced at a rate of 1 volt per minute for a motor rated at 30 volts or less and at a rate of 5 volts per minute on a nominal 120-volt (or 240-volt) motor until a temperature control or a limit control operates to open all heater and motor circuits. If all heater and motor circuits do not open, then the motor speed shall be reduced in accordance with 46.3.5. The motor voltage at the control operation is to be recorded and that value is to be subtracted from the voltage value recorded at intended motor speed. The motor voltage at the control operation is to be increased by 10 percent of this difference unless a larger increase is required to prevent the temperature control from reopening. The motor speed at the test voltage is to be recorded for reference purposes. The appliance is to be operated at this value of voltage applied to the motor until constant temperatures are recorded. If the limit control operates, separate samples are necessary.

Exception No. 1: The voltage to the motor may be decreased at a different rate if agreeable to all concerned.

Exception No. 2: The test speed may be determined by recording motor speeds and using the formula:

$$S = 0.1\,(S_1 - S_2) + S_2$$

in which:

S is the test speed;

S_1 is the motor speed at intended operation; and

S_2 is the motor speed that causes a temperature or a limit control to open all heater and motor circuits.

46.3.5 If all heater and motor circuits are not interrupted by operation of a temperature control, then the motor speed is to be reduced until the limit control operates or until the motor stops. Temperatures are to be monitored to determine the speed at which highest temperatures are recorded. The appliance is then to be operated at that speed until constant temperatures are recorded.

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46.4 Temperature test – motor slowdown

46.4.1 Three previously untested samples of a hand-supported hair dryer, provided with thermocouples, are each to be operated at maximum permitted wattage (110 percent of rated wattage, in accordance with 45.1), but with the motor speed reduced in accordance with 46.3.1 – 46.3.5. The test is to be conducted under the conditions (sample position; heat setting; with or without attachments, if provided, on the air outlet nozzle) that produce the most adverse results.

Exception: If the temperature control operates before 110 percent of rated wattage can be achieved, the wattage is to be reduced to slightly below the point at which the temperature control functions, but not less than the rated wattage of the appliance, so that the sample will be operating at the maximum achievable wattage. There shall be no opening of the limit control, if provided.

46.4.2 A temperature on the hair dryer or on the thermocouple grid exceeding the limits specified in Table 46.1 and Table 46.2 and in 46.2.1, or circuit interruption by component burnout is unacceptable

Exception No. 1: The motor temperature limits as specified in item (A) of Table 46.1 are not applicable to a motor operating below the intended speed.

Exception No. 2: An additional maximum temperature of 10°C (18°F) on thermoplastic material is acceptable when there is no visible physical change in the material such as warping, distortion, flow, creep, or similar condition that would impair the effectiveness of the material after the unit has been operated continuously for 7 hours under the operating conditions that resulted in maximum recorded temperatures on the material.

Exception No. 3: This requirement does not apply to the temperature limits specified in subitem (3) to item (c) of Table 46.1.

46.5 Wax depilatory appliances

46.5.1 The appliance is to be loaded with the maximum recommended amount of wax and operated continuously until constant temperatures have been reached. An adjustable temperature control is to be set for maximum heating. If the appliance has several heat settings for different functions (as noted in 11.3.3), it is to be operated at the highest heat setting, as well as at the maximum setting intended to maintain the molten wax at the temperature for application to the skin.

46.5.2 The wax temperature is to be measured by means of a thermocouple immersed beneath the surface of the wax to a depth of approximately one-half of the total depth, at the approximate center of the reservoir. The wax is to be slowly and continuously stirred while temperatures are being recorded. For depilatory appliances having self-contained wax applicators (no open reservoirs), thermocouples are to be inserted into the wax applicators to a depth of approximately one-half of the total depth of the wax.

46.5.3 In addition to complying with the requirements specified in 11.3.1, 11.3.2, and 46.1.1, the visible overheat condition indicator, when required as specified in 11.3.3(b), shall function when the wax temperature exceeds 75°C (167°F).

47 Dielectric Voltage-Withstand Test

47.1 Primary circuits

47.1.1 While at its maximum operating temperature under conditions of intended use, an appliance shall withstand for 1 minute without breakdown, the application of a 60-Hz, essentially sinusoidal potential:

a) Between live parts and dead-metal parts;

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b) Between circuits that are at different potentials and are not electrically connected (this includes the primary and secondary circuits of isolating transformers);

c) Between terminals of a capacitor used across the line; and

d) Between terminals of a line-bypass capacitor connected between the line and the enclosure.

47.1.2 The test potential shall be as specified in Table 47.1.

Table 47.1
Dielectric test potential for primary circuits

Appliance	Test potential, volts
An appliance not intended to be applied directly to a person, such as a wig dryer, hair curler heater (hair setter), hand-supported hair dryer, and similar products	1000
An appliance intended to be applied directly to a person but without moisture present, such as a dry curling iron	1000 + 2V[a]
An appliance (or attachment provided with it) intended to be applied in a wet or moist condition directly to a person, such as a steam curling iron	2500[b]
An appliance such as a hair dryer-styler or hair untangler having comb or brush accessories, or both, that may be used for setting or styling of wet or damp hair	2500[b]

[a] V is the maximum marked voltage but not less than:

1) 120 volts for a nominal 120-volt appliance or

2) 240 volts for a nominal 240-volt appliance.

[b] A 2500-volt potential is also to be applied to the metal foil-wrapped handle of a hand-supported appliance, and to selected switch areas of any other appliance.

47.1.3 With respect to 47.1.1, an appliance that has no exposed dead-metal parts is to be tightly wrapped in metallic foil, and the test potential is to be applied between the foil and all live parts.

47.1.4 If an autotransformer is in the circuit, a 60-Hz essentially sinusoidal potential of 1000 volts plus twice the rated voltage shall be applied to all circuits operating at more than 250 volts.

47.1.5 The primary of the autotransformer shall be disconnected and the test potential shall be applied directly to the wiring that involves the higher potentials.

47.1.6 To determine whether an appliance complies with the requirements in 47.1.1 and 47.1.2, the test is to be conducted using a 500 volt-ampere or larger capacity testing transformer, the output voltage of which is essentially sinusoidal and can be regulated. The applied potential is to be increased from zero until the required value is reached, and is to be held at that value for 1 minute. The increase in the applied potential is to be at a substantially uniform rate and as rapid as is consistent with its value being correctly indicated by a voltmeter.

47.1.7 If the current leakage across the line, or from line to earth ground, is sufficiently large so it is not possible to maintain the required alternating-current test potential, the appliance may be tested as described in 47.1.8.

47.1.8 The appliance mentioned in 47.1.7 is to be subjected to a direct-current test potential of 1.414 times the appropriate alternating-current voltage. The direct-current test potential is to be maintained for 1 minute without breakdown.

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47.2 Secondary circuits

47.2.1 Secondary circuits of an appliance shall withstand for 1 minute the application of a test potential:

a) Between primary and secondary circuits;

b) Between secondary circuits and grounded metal with all chassis-connected components disconnected at the chassis; and

c) Between secondary circuits supplied from separate transformer windings with common connections disconnected.

The appliance shall be at its maximum intended operating temperature during the test. The test potential shall be as indicated in Table 47.2 and 47.2.3.

Table 47.2
Magnitude of test potential for secondary circuits

Maximum volts rms (volts peak) in the circuit[a]	Test potential
30 (42.4) or less	No test
More than 30 (42.4) but not more than 333.3 (471.3)	10 times maximum voltage in the circuit (maximum of 1000 V rms)
More than 333.3 (471.3) but not more than 1000 (1414)	3 times maximum voltage in the circuit
More than 1000 (1414)	1750 V plus 1.25 times the voltage in the circuit

[a] If the peak voltage is greater than 120 percent of 1.414 times the rms voltage, the circuit shall be tested as if the voltage were peak voltage divided by 1.414.

47.2.2 While at its intended operating temperature, each power transformer shall operate without breakdown while a potential indicated in Table 47.2 is induced for 1 minute in each secondary winding that furnishes power at a higher potential than the primary windings.

Exception: Windings of transformers that do not serve a prime power-supply function, such as a resonant winding of a constant-voltage transformer, are not required to be subjected to this test.

47.2.3 The test potential mentioned in 47.2.1 may be obtained from any convenient source having a capacity of at least 500 volt-amperes to maintain the potential indicated in Table 47.2. The voltage of the source is to be continuously variable. A direct-current source is to be used for a direct-current circuit. A 60-Hz, essentially sinusoidal voltage shall be used for testing an alternating-current circuit.

47.2.4 A sinusoidal source is to be used for a transformer, and the frequency of the source is to be in the range of 180– 1000 Hz when required to avoid saturation of the core.

47.2.5 Primary- and secondary-circuit wiring connected to a transformer is to be disconnected for the test described in 47.2.2.

47.2.6 Starting at zero, the test potential is to be increased gradually until the voltage indicated in Table 47.2, is reached or until dielectric breakdown occurs. The potential is to be held at that level for 1 minute.

48 Leakage Current Test Following Humidity Conditioning

48.1 An appliance shall comply with the requirements for leakage current in 42.1 following exposure for 48 hours to air having a relative humidity of 88 ±2 percent at a temperature of 32 ±2°C (90 ±4°F).

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48.2 To determine whether an appliance complies with the requirement in 48.1, a sample of the appliance that has been preheated to a temperature just above 34°C (93°F) is to be contained in a chamber under the time, humidity, and temperature conditions specified. After the conditioning, while still in the chamber, the sample is to be tested unenergized as described in 42.7(a). The sample, either in or immediately after being removed from the chamber, is to be energized and tested as described in 42.7 (b) and (c). The test is to be discontinued when the leakage current stabilizes or decreases.

49 Immersion Protection Trip Time Measurement Test

49.1 As-received hair dryers

49.1.1 Samples of hair dryers that are provided with an immersion protection shall be subjected to the tests described in 49.1.2 – 49.1.7. The results are acceptable if the immersion protection trips, to interrupt the flow of current to ground within a trip threshold of 5 mA +/ 1 mA andtime interval, T, when the current to ground, I, is within the range of 4 – 6 mA, in accordance with the relationship:

$$T = \left[\frac{20}{I}\right]^{1.43}$$

in which:

T is the interval in seconds and

I is the current to ground in milliamperes (mA) rms.

49.1.2 Three untested hair dryer samples, in each of the following configurations, are to be tested individually in accordance with 49.1.3 and 49.1.4, while connected to their rated source of supply as described in 40.2, and then connected to a voltage equal to 85 percent of the rated voltage. Each test is to be conducted with three untested the hair dryer samples in each of the following configurations (including the orientation that results in the most unfavorable condition of use):

a) Hair dryer switch in the off position, heat/speed switch in the most unfavorable setting if applicable, and

1) Appliance plug inserted into the supply circuit receptacle with normal polarity.

2) Appliance plug inserted into the supply circuit receptacle with reversed polarity.

b) Hair dryer switch in the on position, heat/speed switches in the most disadvantageous setting, if applicable, and

1) Appliance plug inserted into the supply circuit receptacle with normal polarity.

2) Appliance plug inserted into the supply circuit receptacle with reversed polarity.

Exception: Testing at 85 percent of rated voltage is not required when the investigation of the immersion protection indicated it will function as intended at 85 percent of rated voltage.

49.1.3 Each of three samples, in each configuration specified in 49.1.2, is to be placed at the bottom of an empty isolated conductive metal tub of a convenient size. The tub is to be equipped such that it can be filled from beneath at a rate of no greater than 5 inches (127 mm) of water per hour. The tub is to be connected to earth ground through a noninductive 500-ohm resistor. As the tub is filled, the leakage current is to be continually measured and a trace of the current flow as a function of time is to be obtained. The water flow is to be stopped when the leakage current reaches 6 mA or the immersion protection functions, whichever occurs first. One minute after the immersion protection has tripped and without

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changing any of the test conditions, a user resettable immersion protection is to be reset and the current value and tripping time measurements are to be repeated. The results are acceptable if in each immersion the immersion protection trips to interrupt the flow of current to ground within a trip threshold of 5 mA ±1 mA, in accordance with the trip time equation in 49.1.1.

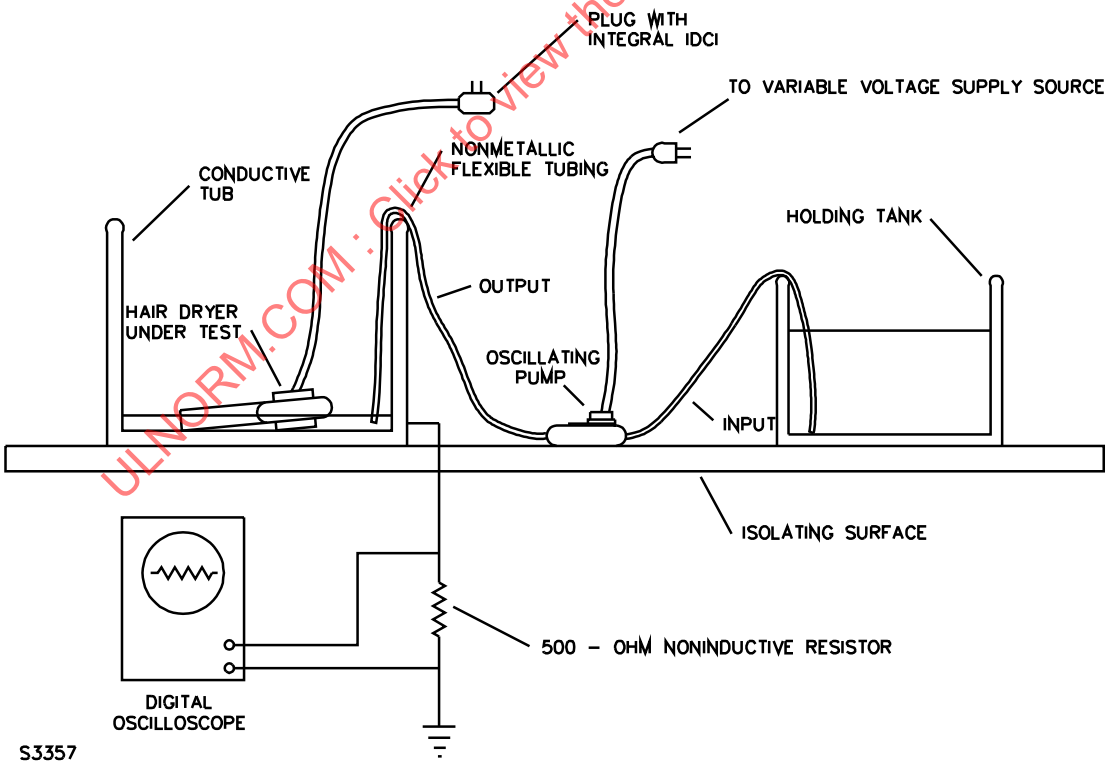
49.1.4 The isolated tub described in 49.1.3 is to be filled with 12 inches (305 mm) of water. Each of three samples, in each configuration specified in 49.1.2, is to be dropped into the water such that different surfaces of the sample strike the water first. The leakage current is to be continuously measured and a trace of the current flow as a function of time is to be obtained. The results are acceptable if in each immersion the immersion protection trips to interrupt the flow of current to ground within a trip threshold of 5 mA ±1 mA, in accordance with the trip time equation in 49.1.1.

49.1.5 The tests specified in 49.1.2 – 49.1.4 are to be conducted two separate times using water with a resistivity of 200 ohm-cm and 20,000 ohm-cm as described in 49.1.7.

49.1.6 Typical test arrangement for the test described in 49.1.3 is shown in Figure 49.1. In the arrangement, the pump is connected to a source of supply of variable voltage so that the water flow rate may be regulated. The tubing that connects the holding tank to the pump and the pump to the conductive tank is nonmetallic flexible tubing (such as aquarium air hose) and is of such length that it extends to the bottom of the conductive tub so that the water fills the tub from below.

Figure 49.1

Immersion protection trip test arrangement



49.1.7 The water resistivities specified in 49.1.5 are to be obtained by the addition of sodium chloride (common table salt) to distilled water or tap water. The water temperature is to be 20 – 40°C (68 – 104°F).

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49.2 Conditioned hair dryers

49.2.1 Separate samples that are provided with immersion protection, shall be subjected to each of the following tests in (a) – (g):

a) The motor short-circuit test [50.1.4(f)];

b) The drape test (50.3.10.1);

c) The blocked fan test (50.3.11.1);

d) The bypassed temperature control test (50.3.12.1 and 50.3.14.3);

e) The restricted air inlet test (50.3.13.1 – 50.3.13.4);

f) The restricted air outlet test (50.3.14.1 – 50.3.14.3); and

g) The floor drop test (50.3.15.1 and 50.3.15.2).

Then these samples shall be subjected to tests specified in 49.1.2 – 49.1.7.

49.2.2 The tests on the conditioned samples are to be conducted using the on-off switch position, the heat-speed selector switch(es) position(s), the supply circuit voltage and polarity, the water resistivity, and the like as specified in 49.1.2 and 49.1.5, that resulted in the highest leakage current and longest immersion protection trip time determined in accordance with 49.1.3. The results are acceptable if in each immersion the immersion protection trips to interrupt the flow of current to ground within a trip threshold of 5 mA ±1 mA, in accordance with the trip time equation in 49.1.1.

50 Abnormal Operation Test

50.1 General

50.1.1 An appliance shall not present a risk of fire or electric shock when operated under abnormal conditions that are likely to occur during intended use.

50.1.2 If there is a conflict between the test conditions described in 50.2.1 – 50.2.13 and those described for specific appliances in 50.3.2.1– 50.3.18.2, the test conditions for specific appliances shall apply.

50.1.3 With reference to the requirement in 50.1.1, a risk of fire or electric shock is considered to exist if any of the following occur:

a) Glowing, charring, or flaming of the cheesecloth or tissue paper as specified in 50.2.1 and 50.2.2;

b) Opening of the 3-ampere fuse specified in 50.2.3;

c) Emission of flame, sparks, or molten metal from the appliance enclosure;

d) Development of an opening in the overall enclosure that exposes live parts involving a risk of electric shock to contact by persons (see 9.4.1 – 9.4.8); or

e) Loss of structural integrity to a degree where the appliance collapses or experiences such displacement of parts that may lead to short-circuiting or grounding of live parts, or in the case of a direct plug-in appliance, the appliance cannot be removed from a receptacle immediately after the test without deformation that may present a risk of electric shock.

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50.1.4 Malfunction of components and likely misuses of the appliance that could result in a risk of fire or electric shock are to be simulated during abnormal tests mentioned in 50.1.1. Examples are as follows:

a) Belt breakage of a fan or blower assembly that ventilates a heater or a similar source of heat.

b) Malfunction of an automatic-reset thermostat, a timer switch, or a similar device that could result in continuous energization of a heat source.

c) Stalled rotor of a drive motor, fan motor, or similar part.

d) Blockage in the de-energized position of the armature or plunger of an open-coil electromagnetic relay or solenoid.

e) Operation of an appliance without fluid or liquid. An appliance in which a liquid is heated is to be operated dry and, other than as noted in 50.1.5, with all automatic-reset thermostats shunted out of the circuit.

f) Short-circuiting of a motor in a limited-energy primary circuit unless the motor is provided with an insulation system and spacings acceptable for the line-voltage involved.

g) Malfunction of electronic components.

h) Continuous operation of an appliance with the secondary of a transformer or the output of power supply that limits the current to 8 amperes or less as described in 36.1.2 and 36.1.8 at applicable overload conditions including short-circuit.

i) Connection of an interconnecting cord or cable by interchanging or misaligning the connector in any combination permitted by the construction.

50.1.5 A switch mechanism or a thermostat as mentioned in 50.1.4 (b) – (e) that has been shown to be rugged, reliable, and unlikely to be defeated by the user is to be assumed acceptable, and malfunction of such a component is not to be simulated during the abnormal operation test. A switch or a thermostat is considered to be rugged and reliable if it has been subjected to a 100,000-cycle endurance test under load. The 100,000-cycle endurance test is to cover the mechanical parts that actuate the switch as well as the electrical parts. A switch or a thermostat is considered to be unlikely to be defeated by the user if tools are required to gain access to it, or a positive stop is incorporated on the device.

50.1.6 With respect to the malfunction of electronic components as mentioned in 50.1.4(g), the circuit between any two terminals of a device such as a rectifier, a transistor, a capacitor, a resistor, or a similar component is to be opened or shorted. Only one of the simulated fault conditions is to be imposed at one time. For a multi-terminal device, only two terminals shall be short-circuited at a time. Simulated circuits may be used, but if the tests performed on simulated circuits indicate likely damage to other parts of the appliance to the extent that the safety of the appliance may be affected, the test shall be repeated in the appliance.

Exception No. 1: A component located in the following circuits is not required to be open- or short-circuited:

a) A low-voltage circuit;

b) A circuit that has been investigated for reliability; or

c) A circuit that would not involve a risk of fire or electric shock if a component malfunction were to occur.

Exception No. 2: A wire-wound resistor is not required to be short-circuited.

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Exception No. 3: A resistor that has been shown by an investigation to be reliable is not required to be open- or short-circuited.

50.1.7 When abnormal operation tests are conducted, the intended usage of the appliance is to be taken into account. For example, if the appliance is provided with a momentary contact switch having no provisions for being locked in the on position and if there is indication of malfunction (abnormal operation of the appliance, emission of smoke, failure of the appliance to operate in the intended manner, or other similar indication), the test is to be discontinued when the malfunction becomes evident. Otherwise, the test is to be continued until ultimate results occur.

50.2 General test conditions

50.2.1 Abnormal operation tests are to be made with the appliance supported in its intended operation position. A cord-connected appliance is to be placed on a pine board covered with white tissue paper.

50.2.2 During the tests, the appliance is to be draped with a double layer of cheesecloth conforming to the outline of the appliance.

50.2.3 During each test, exposed dead-metal parts of the appliance are to be connected to earth ground through a 3-ampere, nontime-delay fuse.

50.2.4 The appliance is to be connected to a supply source of the voltage and frequency specified in 42.2. The supply circuit is to have the maximum-sized overcurrent protective device that, in intended use, would be selected for branch-circuit protection in accordance with the National Electrical Code, ANSI/NFPA 70. Temperature control adjustments or other user-adjustable controls, if any, are to be set in the position that will result in the most severe test.

50.2.5 A user-serviceable fuse is to be effectively defeated unless marked in accordance with 50.2.13. A fuse that is soldered in place, or is located such that it is accessible only to qualified service personnel, and marked in accordance with 50.2.13, and any other overcurrent protective device not subject to user replacement may be left in the circuit.

50.2.6 Only one abnormal condition is to be simulated at one time.

50.2.7 Each test is to be conducted on a separate sample unless it is agreeable to those concerned that more than one test may be conducted on the same sample.

50.2.8 A part of an appliance that may be removed during user servicing may be omitted if:

a) It is not required for the functioning of the appliance;

b) It is not exposed to view during intended operation; and

c) It is not captivated.

50.2.9 If an appliance is provided with means for controlling speed, the test is to be conducted at both the maximum and minimum speed settings of the control, and may be conducted at intermediate speed settings.

50.2.10 The abnormal operation test is to be conducted for 7 hours or until one or more of the following results are observed:

a) A risk of fire or electric shock develops. See 50.1.3.

b) The branch-circuit fuse opens.

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c) The appliance protective device opens.

d) Any other circuit component opens.

e) A minimum of one hour has elapsed, circuit conditions have stabilized, and there is no further evidence of overheating of parts.

50.2.11 The overheating of parts referred to in 50.2.10(e), may be detected by such an indicator as odor, smoke, discoloration, cracking of materials, charring, flaming, glowing, arcing, changes in circuit current through the applied fault, or any similar phenomenon.

50.2.12 If a fault condition is terminated by opening of a circuit component as specified in 50.2.10(d), the test is to be repeated two more times using new components for each test.

50.2.13 A fuse that is relied upon during these tests (see 50.2.5) is to be marked in accordance with 79.4.1.

50.3 Specific test conditions

50.3.1 General

50.3.1.1 For most of the common types of appliances, standardized abnormal conditions are given in 50.3.2.1 – 50.3.18.2.Appliances having features not contemplated in test procedures in 50.3.2.1 – 50.3.18.2 may be tested as necessary to take such features into account.

50.3.2 Drape test for curling irons

50.3.2.1 A curling iron is to be operated without any separable stand on a softwood surface covered with two layers of white tissue paper. The curling iron is to be covered loosely with a double layer of cheesecloth.

50.3.3 Blocked steam outlet test for steam-type curling irons

50.3.3.1 A steam-type curling iron is to be energized at rated wattage, and the water reservoir filled with a solution of hard water (1/2 gram of calcium sulfate, $CaSO_4 \cdot 2H_2O$, per liter of distilled water) in an amount equal to the capacity of the reservoir. With the steam outlet opening blocked, a steam actuator control is to be operated at the fastest possible rate that produces steam, until the water supply is exhausted or for 15 minutes, whichever occurs first. During this test, the sample is to be positioned in the most unfavorable position with respect to internal components, and the leakage current is to be continuously monitored. The result is acceptable if the leakage current does not exceed that specified in 42.1. Immediately following the test, the sample shall be subjected to a 2500-volt dielectric voltage-withstand test as described in 47.1.1 – 47.1.8. The result is acceptable if there is no dielectric breakdown.

50.3.4 Overfill test for steam-type curling irons

50.3.4.1 A steam-type curling iron having an integral liquid reservoir shall be subjected to an overfill test consisting of pouring a solution of hard water as described in 50.3.3.1 into the reservoir. The amount of solution shall be 200 percent of the capacity of the reservoir. During the test, the appliance is to be held in its "fill" position and the leakage current continuously monitored. The result is acceptable if the leakage current does not exceed that specified in 42.1. Immediately following the test, the sample shall be subjected to a 2500-volt dielectric voltage-withstand test as described in 47.1.1– 47.1.8. The result shall be no dielectric breakdown.

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50.3.5 Water droplets test for steam-type curling irons

50.3.5.1 To determine if a steam-type curling iron having an integral liquid reservoir will need to have the wording specified in 81.9(g)(14), the appliance shall be subjected to a water droplet test consisting of pouring a solution of hard water, as described in 50.3.3.1, into the reservoir. The amount of solution shall be the specified capacity of the reservoir. During the test, the appliance is to be operated at rated wattage. Commencing with the appliance cold, and ending beyond the point when the appliance becomes fully heated, the appliance steam control system is to be actuated continuously. If no water droplets are emitted from the steam vents at any time during the test, the appliance Important Safety Instructions is not required to include the information described in 81.9(g)(14).

50.3.6 Overfill test for mist-type hair dryers

50.3.6.1 A mist-type hair dryer having an integral liquid reservoir shall be subjected to an overfill test consisting of pouring a solution of hard water as described in 50.3.3.1 into the reservoir. The amount of solution shall be 200 percent of the capacity of the reservoir. During the test, the appliance is to be held in its "fill" position and the leakage current continuously monitored. The result is acceptable if the leakage current does not exceed that specified in 43.1. Immediately following the test, the sample shall be subjected to a 2500-volt dielectric voltage-withstand test as described in 47.1.1 – 47.1.8. The result is acceptable if there is no dielectric breakdown.

50.3.7 Drape test for hair dryers other than hand-supported types

50.3.7.1 A hair dryer (both heating element and blower) is to be operated, without the use of a dummy head, until all temperatures stabilize. The hair dryer, while still operating, is then to be draped with a double layer of cheesecloth in such manner as to retard the air flow effectively and to cover the hottest area of the appliance. However, the cheesecloth is not to be manipulated deliberately in an endeavor to cause an overly restricted air flow.

50.3.8 Blocked fan test for hair dryers other than hand-supported type

50.3.8.1 A hair dryer is to be subjected to a test with the rotor of the blower blocked and the temperature control, if any, set in the position that will result in the most severe test.

50.3.9 Softwood surface temperature test for hand-supported hair dryers

50.3.9.1 A hand-supported hair dryer is to be laid on a flat, horizontal, softwood surface covered with two layers of white tissue paper, and operated until constant temperatures have been attained. During this test, both the heating element and the blower are to be operating, and the position of the hair dryer is to be such that (considering the possibilities of actual service) the maximum temperature will be produced on the paper-covered supporting surface. The maximum acceptable temperature on the paper is 150°C (302°F).

50.3.10 Drape test for hand-supported hair dryers

50.3.10.1 A hand-supported hair dryer is to be positioned as described in 50.3.9.1. The hair dryer, while still operating, is then to be draped with a double layer of cheesecloth in such manner as to retard the air flow effectively and to cover the hottest area of the appliance. However, the cheesecloth is not to be manipulated deliberately in an endeavor to cause an overly restricted air flow.

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50.3.11 Blocked fan test for hand-supported hair dryers

50.3.11.1 A hand-supported hair dryer is to be subjected to a test with the rotor of the blower blocked and the temperature control, if any, set in the position that will result in the most severe test. During the test, a single layer of cheesecloth is to be loosely draped over the hair dryer.

50.3.12 Bypassed temperature control test for hand-supported hair dryers

50.3.12.1 Three samples of a hand-supported hair dryer shall each be subjected to an abnormal operation test in accordance with 46.4.1, except that:

a) All temperature controls are to be simultaneously bypassed;

b) A 3-ampere fuse is to be connected between exposed dead-metal and ground; and

c) The motor speed is to be further reduced at a rate of 1 volt per minute for a motor rated at 30 volts or less and at a rate of 5 volts per minute on a nominal 120-volt (240-volt) motor until all heater and motor circuits are interrupted by operation of a limit control, or the motor speed is to be reduced to a stop condition until ultimate results are obtained.

50.3.12.2 In addition to the conditions specified in 50.1.1, the results are not acceptable if a sample after being subjected to the test specified in 50.3.12.1:

a) Permits the accessibility probe as illustrated in Figure 9.1 to enter the enclosure and to contact an uninsulated live part;

b) Is unable to comply with the dielectric voltage-withstand test specified in 47.1.1;

c) Experiences circuit interruption other than by operation of a limit control;

d) Has caused the 3-ampere fuse to ground to open; or

e) If still in an operating condition, exceeds the temperature limits specified in Table 46.1 and Table 46.2, when tested as described in 46.4.1 and 46.4.2.

50.3.13 Restricted air inlet test for hand-supported hair dryers

50.3.13.1 Three samples of a hand-supported hair dryer shall each be subjected to a restricted air inlet condition in which the unit is oriented in the most adverse operating condition and operated at the maximum permitted wattage (110 percent of rated wattage in accordance with 45.1) and at the highest heat and motor speed settings. The air inlet opening shall be gradually obstructed until the operation of all circuits is interrupted by the functioning of a limit or a temperature control, or until ultimate results are otherwise obtained (see 50.3.13.2). If the highest heat and motor speed settings do not result in the most adverse condition, the restricted air inlet procedure is to be repeated under conditions that produce the most adverse results. In addition to meeting the requirements specified in 50.1.1, there shall be no circuit interruption other than by operation of a limit control.

50.3.13.2 The air intake openings are to be gradually obstructed by using layers of terrycloth, as defined in 50.3.13.3, sized at least 2 inches (50.8 mm) greater than the dimension of the intake opening, to be placed over the opening one additional layer at 3 minute intervals up to a maximum of 10 layers for 7-1/2 hours of operation, at which point ultimate results may be considered obtained. If the layers of terrycloth do not remain in place to restrict the air opening, then additional restraint, such as taping, may be necessary to hold the terrycloth in place. Tape is not to be used as the means of blocking the air openings. If the unit is provided with two separate sets of intake openings (such as a gun-type hair dryer), both sets of intake openings are to be gradually obstructed simultaneously.

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50.3.13.3 Fabric used in the test described in 50.3.13.2 shall be white, 100 percent untreated cotton terrycloth having a pile weave and a nominal weight of 8 ounces per square yard (271 g/m^2).

50.3.13.4 The same test conditions specified in 50.3.13.1 and 50.3.13.2 shall be applied, but with all temperature controls simultaneously bypassed and with no additional layers of terrycloth added after the limit control operates. When the limit control operates, the test shall be stopped.

50.3.14 Restricted air outlet test for hand-supported hair dryers

50.3.14.1 When tested as described in 50.3.14.2 and 50.3.14.3, a hand-supported hair dryer shall comply with the requirements specified in 50.1.1, and there shall be no circuit interruption other than by operation of a limit control.

50.3.14.2 Three samples of a hand-supported hair dryer shall each be tested. Each sample is to be oriented in the most adverse operating condition and operated at the maximum wattage (110 percent of rated wattage in accordance with 45.1) and at the highest heat and motor speed settings. The air outlet is to be gradually obstructed using masking tape such that approximately 50, 75, 90, and 100 percent of the outlet opening area is progressively blocked for 3 minutes at each of the four positions. For each of three samples, the location at which the blocking begins (the top, a side, or bottom) is to progress in the same direction in which it was started and is to be such that the limit control will remain in the air flow for the longest possible time as blocking progresses. If temperatures cause degradation of the tape, or if the use of tape would cause deformation of an outlet nozzle, a metal plate or other material resistant to combustion may be used to block the outlet opening. If the final 100 percent blockage test does not result in interruption of all heater and motor circuits by a limit control, the test is to be continued, at 100 percent blockage, for 7-1/2 hours, at which time ultimate results are considered to be achieved.

50.3.14.3 The same test conditions specified in 50.3.14.2 shall be applied, but with all temperature controls simultaneously bypassed. When the limit control operates, the test shall be stopped.

50.3.15 Floor drop test for hand-supported hair dryers

50.3.15.1 Each of three samples (without thermocouples) shall be operated at rated wattage and at maximum intended speed. While operating, they shall be dropped three times from a height of 3 feet (914 mm) onto a hardwood surface so that the point of impact is different for each of the three drops. After each drop, compliance with 50.3.12.2 (a), (c), and (d) shall be determined. After the third drop of each sample, compliance with 50.3.12.2 (b) and (e) shall be determined.

Exception: It is acceptable for a heating element to break if tests show after this occurs the appliance consistently:

a) Complies with the requirements in 50.1.1 and 50.1.3 and

b) Has no spacing reduced below the minimum required value.

50.3.15.2 If a hand-supported hair dryer appears operable following the three drops, it is to be set up as indicated for the full motor speed test, 46.2.2.1, and temperatures on the thermocouple grid are to be recorded. In addition, current input to the unit and motor speed are to be recorded. If the temperatures on the thermocouple grid do not exceed the limits specified in 46.2.2.1 and if the current input to the unit and the motor speed do not differ from the values obtained in the initial full motor speed test by more than ±10 percent, the test results are considered acceptable and the test is to be discontinued.

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50.3.16 Broken heating element test for hand-supported hair dryers

50.3.16.1 The heating element in a hand-supported hair dryer shall be constructed so that, if the wire is cut at any point, there shall be no reduction of electrical spacings below the limits specified in this standard. After being cut, no portion of the heating element wire shall be accessible to contact by the accessibility probe, as illustrated in Figure 9.1, through any opening in the enclosure while the hair dryer is rotated and moved as intended during use without intentional jerking or shaking. The test shall be conducted on an as-received sample or on a sample that has been conditioned by 1 hour of continuous, intended operation with heat selectors set for maximum heat. In the event that unacceptable results are obtained on an as-received sample, a referee test shall be conducted on a conditioned sample.

50.3.17 Hair curler heater test for hair curler heaters (hairsetters)

50.3.17.1 If a hair curler heater employs one or more automatic-reset thermostats, the thermostats are to be short-circuited and the appliance is to be operated under the conditions described in 50.3.17.2. Six samples of the appliance are to be tested.

50.3.17.2 Three samples of the hair curler heater are to be tested with the curlers in place, and three samples are to be tested without the curlers. The samples are to be arranged for operation under the most adverse condition, including with the cover closed if the appliance can be so operated.

50.3.17.3 A manually reset protector or a thermal cutoff used to provide compliance with the requirement in 50.3.17.1 shall not function during the normal temperature test.

50.3.18 Hair entanglement test for bonnet-type hair dryers

50.3.18.1 A bonnet- or helmet-type hair dryer with the heater and blower integral with the headpiece shall be subjected to the test described in 50.3.18.2.

50.3.18.2 A sample of the hair dryer is to be mounted on a stand and connected to a supply circuit as specified in 40.2. The hair dryer bonnet is to be installed in the intended operating position over a "dummy" head equipped with orifices, pivot tubes, and interconnecting tubing such that air pressure can be measured at various points on the head. While the hair dryer is operating, air pressures are to be measured by means of an air pressure gage having a scale of minus 0.10 inch of water (0.025 kPa) to plus 0.14 inch of water (0.035 kPa). Results are acceptable if no negative pressures are recorded on the gauge.

Exception: Negative air pressure may be acceptable if an investigation shows that hair entanglement is not likely to occur.

50.3.19 Wax depilatory appliances

50.3.19.1 If a wax depilatory appliance uses one or more automatic reset temperature controls, all such controls are to be short-circuited and the appliance is to be operated under the conditions described in 50.3.19.2 and 50.3.19.3.

Exception: Acceptable limit controls tested for 100,000 cycles of operation are not to be short-circuited.

50.3.19.2 The appliance is to be operated empty and also with the maximum recommended amount of wax. A movable part or cover is to be in the intended position resulting in the most adverse conditions. A self-closing cover (as described in 11.3.4) is to remain in its closed position.

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50.3.19.3 One sample is to be tested under each condition in 50.3.19.2. Each sample is to be placed on a white, tissue-paper-covered soft pine wood surface in a draft-free location. The sample is to be draped with a double layer of cheesecloth and connected to a circuit of the voltage as specified in 46.1.19. Adjustable temperature controls are to be set for maximum heating. Exposed dead-metal parts of the appliance are to be connected to ground through a 3 ampere, nontime-delay plug fuse. Operation is to be continued in this manner for 7-1/2 hours, or until a manual reset limit control or thermal cutoff opens the circuit. If a limit control can be manually reset without disassembling the appliance, the control is to be held in the on position until 7-1/2 hours of operation elapse or the ultimate results are obtained. If a manually-reset limit control cannot automatically reset when the reset means is held in the "on" position, the control is to be reset as quickly as possible after each tripping for a total of four times or for the number of cycles for which it can be reset during the 7-1/2-hour period, whichever is less. The maximum temperature of the wax, as specified in 46.5.3, shall be recorded during wax heating. The maximum temperatures of the interior surface(s) of the wax reservoir(s) shall be recorded during wax heating and empty operation.

50.3.19.4 The results are acceptable if:

a) There is no glowing of the supporting surface, flaming of the cheesecloth, or similar manifestation of a risk of fire;

b) There is no degradation of the enclosure material exposing uninsulated current-carrying parts to contact;

c) The fuse in the grounding connection does not rupture; and

d) The maximum wax and empty reservoir temperatures do not exceed the flash point temperature of the wax, as determined by the Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester, ASTM D93.

50.3.19.5 An abnormal test is also to be conducted by operating the appliance under the conditions of intended use, as described in 46.5.1 and 46.5.2, but defeating the temperature control that operates to keep the wax temperature at or below 75°C (167°F). The visible overheat condition indicator specified in 11.3.5 shall function when the wax temperature exceeds 75°C.

51 Exposure to Moisture Test

51.1 An appliance that may alternately be used wet and dry (such as a hair dryer-styler having comb and brush accessories that may be used for setting or styling of wet or damp hair and then used as a dryer, or a hair untangler) shall be tested as described in 51.2 – 51.6.

51.2 One sample is to be subjected to this test in an unenergized condition. Any attachment is to be oriented to result in the most unfavorable condition of use.

51.3 Each sample is to be oriented above a standard test solution (consisting of 1/2 gram of calcium sulfate per liter of water) so that the comb teeth or the center row (or rows) of brush bristles are pointing vertically downward. While held in this position, and without axial rotation, jerking or shaking, the sample is to be lowered so that the teeth or bristles enter the test solution. The depth of insertion is to be such that the exposed bases of the teeth or bristles are at the surface of the water. The sample is to be held in this position for 2 seconds, removed from the water without changing the angle of the appliance, and then tilted to a vertical position with the accessory end up. This position is to be held for 5 seconds, after which the original position is to be resumed and the sample again dipped into the water as before. This operation is to be repeated without interruption a total of ten times at the nominal rate of six times per minute.

51.4 Following the dipping cycles, and while being held in its final, vertical position, the sample is to be completely and closely wrapped in metal foil which contacts all exposed accessible dead-metal parts, if

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any. The sample is then to be oriented in the most unfavorable position with regard to components (such as switches, and the like) and subjected to the dielectric withstand-voltage test described in 51.5.

51.5 The results are acceptable if the appliance in an unenergized condition withstands for 1 minute without breakdown a 60-hertz essentially sinusoidal potential of 2500 volts applied between live parts and metal foil wrapping as described in 47.1.1 – 47.1.8.

51.6 If the appliance is supplied with one or more accessory attachments, the complete moisture test is to be conducted using each accessory. Samples of the appliance are to be in the intended operating condition for this test.

52 Flooding of Live Parts Test

52.1 To determine whether malfunction or breakdown of a timer switch, float- or pressure-operated switch, or the like will result in a risk of electric shock, an appliance that employs water or another electrically conductive liquid during its operation shall be conditioned as described in 52.2. The results are acceptable if:

a) During and after the conditioning:

1) There is no obvious wetting, as described in 52.4, of any electrical component and

2) For a portable or stationary appliance, when investigated as described in 52.3, the leakage current does not exceed 5.0 milliamperes; and

b) After the conditioning, the appliance:

1) Complies with the dielectric withstand requirements in 47.1.1 and

2) For a permanently-connected appliance, the insulation resistance between current-carrying parts and exposed dead-metal parts is more than 50,000 ohms.

52.2 To determine whether an appliance complies with the requirements in 52.1, the appliance is to be connected to a source of intended liquid. If only a timer switch or only a fill switch (a float-or pressure-operated switch which prevents over filling) is provided, the timer or the fill switch is to be defeated and the appliance started. The fill is to be continued for an additional 15 minutes following the first evidence of overflow of the reservoir. If both a timer switch and a fill switch are provided, two tests are to be conducted. In one test, the timer switch is to be defeated and the fill is to be continued until actuation of the fill switch terminates the fill (which will also terminate the test). In a second test, the fill switch is to be defeated with the timer operating until the fill is terminated (which also terminates the test). Both during and after conditioning, the appliance is to be tested for compliance with 52.1(a); after conditioning, it is to be tested for compliance with 52.1(b).

52.3 A portable or stationary appliance is to be investigated using the method described in 42.2 – 42.8; however, with the concurrence of those concerned, the duration of the test may be shortened.

52.4 Obvious wetting is considered to be wetting by a stream, spray, or dripping of water on the component that obviously will be repeated during each flooding test. Obvious wetting does not include wetting by random drops of water that may wet the component by chance.

53 Overflow Test

53.1 If an appliance other than those mentioned in 50.3.4.1 – 50.3.6.1 incorporates a reservoir or liquid-storage chamber that is likely to be overfilled during intended use and if overfilling can result in a risk of

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fire, electric shock, or injury to persons, the appliance shall comply with the following requirements after being tested as described in 53.2.

a) The appliance shall comply with the requirements for the Dielectric-Voltage-Withstand Test, Section 47;

b) For a cord-connected appliance rated nominal 250 volts or less, the leakage current shall be as specified in 42.1;

c) For an appliance other than as mentioned in (b), the insulation resistance between current-carrying parts and exposed dead-metal parts (or for an appliance with an outer enclosure of insulating material, metal foil wrapped tightly around the enclosure) shall be at least 50,000 ohms; and

d) There shall be no wetting of uninsulated live parts or film-coated wires or electrical insulation that is likely to be adversely affected by the liquid usually used in the reservoir or chamber, as determined by visual inspection.

53.2 A solution of hard water, as described in 50.3.3.1, is to be used for the test and is to be poured into the reservoir through an orifice 3/8 inch (9.5 mm) in diameter. The reservoir is to be filled to the level recommended by the manufacturer if such level is plainly marked; otherwise, the reservoir is to be filled to maximum capacity. Additional test solution, equal to 50 percent of the prescribed fill volume but not more than 1 pint (470 ml), is then to be poured into the reservoir. Upon completion of the above procedure, the appliance is to be tested and visually inspected for compliance with 53.1 (a) – (d).

54 Stability Test

54.1 In accordance with 14.1, a floor- or counter-supported appliance is to be placed on a tilted supporting surface that is inclined at a 10 degree angle from the horizontal, and is to be turned to the position most likely to cause tipping. Any adjustable or movable part that will affect the location of the center of gravity of the appliance is to be placed in the position most likely to contribute to tipping. Blocks are to be used to prevent the appliance from moving down the incline. The results should show that the appliance remains stable on the tilted surface.

54.2 An appliance of the type mentioned in 11.2.1 shall be placed on a plane inclined at an angle of 15 degrees to the horizontal. The appliance shall be positioned and loaded with whatever combination of separable components (strainers, cups, and the like) and liquid that results in the maximum tendency to overturn under conditions of intended use. Blocks are to be used to prevent the appliance from moving down the incline. The appliance shall not overturn as a result of this test.

55 Tip-Over Test

55.1 Three samples of an appliance as described in 11.2.1 are to be tested and each sample is to be tested three times. See Figure 55.1. Each sample of the appliance is to be placed on a horizontal surface of laminated thermosetting counter-top-type material. The appliances are to be oriented in a position that is likely to occur during intended use, and are to contain whatever combination of separable components and liquid that results in the most adverse condition for this test.

Exception: An appliance with a maximum capacity of 17.5 fluid ounces (517 ml) need not comply with these requirements.

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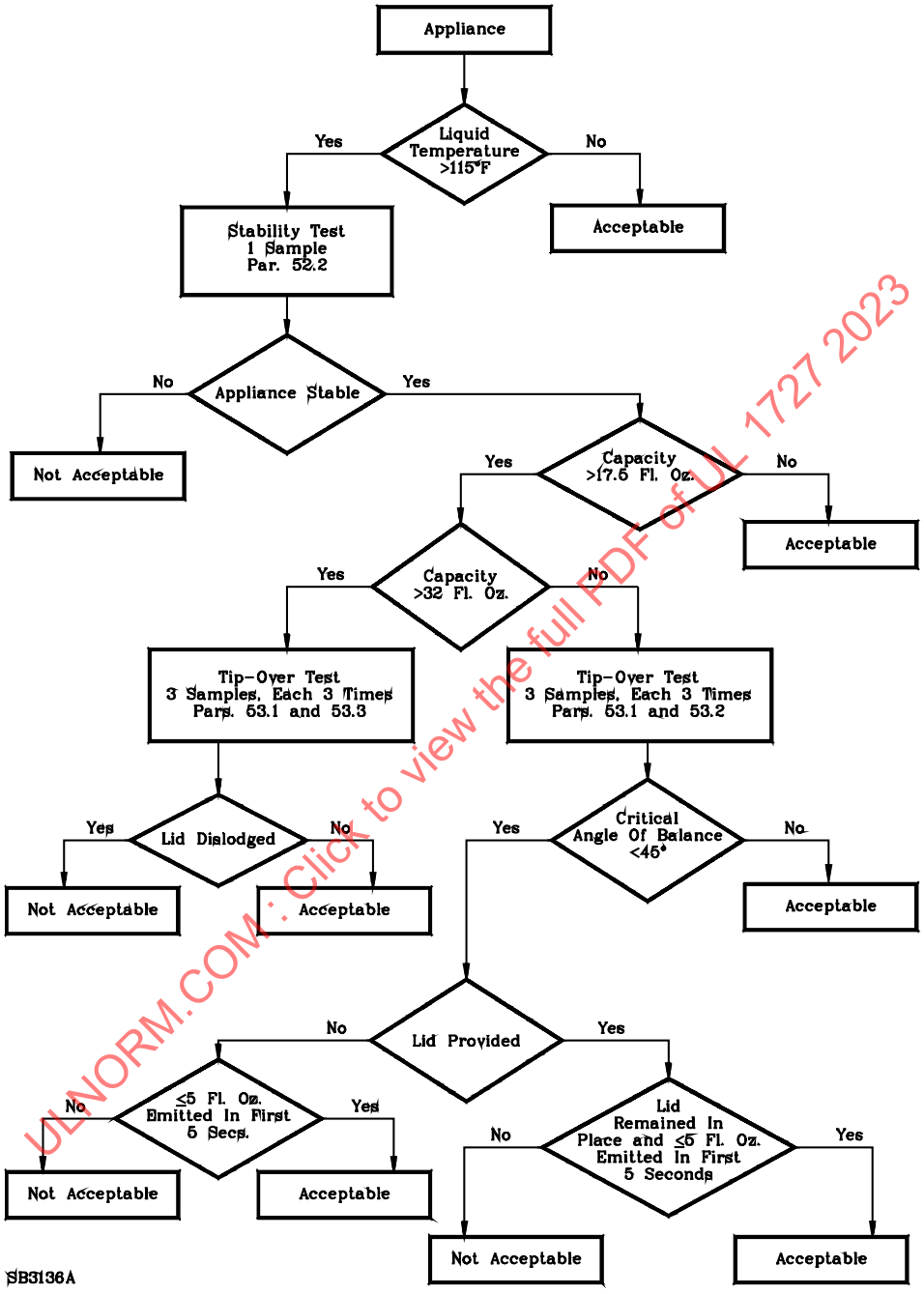
Figure 55.1

Flow diagram for appliances with reservoirs



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55.2 For an appliance with a capacity of more than 17.5 fluid ounces (517 ml) but 32 fluid ounces (945 ml) or less, the sample is to be tilted to determine its critical angle of balance (the angle at which the sample will tip over due only to the force of gravity). The results are acceptable if one of the following occurs:

a) The critical angle of balance from the horizontal is 45 degrees or greater or

b) A lid, if provided, remains in place and the liquid emitted during the first 5 seconds from the appliance during any tip over is no more than 5 fluid ounces (148 ml).

55.3 For an appliance with a capacity of greater than 32 fluid ounces (945 ml), the sample is to be tilted until it tips over due only to the force of gravity. The results are acceptable if the lid remains in place.

56 Strength of Enclosure Test

56.1 A 5-pound force (22.2-N) is to be applied by means of the flat end of a circular steel rod that is 1/4 inch (6.4 mm) in diameter and 5 inches (127 mm) long for 1 minute to any part of the area described in 9.5.1. The rod is to be vertical, and the appliance may be oriented in any position relative to the rod before the force is applied. The results are acceptable if:

a) During the test, the rod does not contact an uninsulated live part and

b) After the test, the construction is in compliance with 9.4.1 – 9.4.3, and 34.2.

56.2 With reference to 56.1, the test is to be conducted on a guard such as a screen, which is located under an opening in an enclosure, through the opening in the enclosure only if the following conditions are met:

a) The guard is:

1) Metal or other electrically conductive material,

2) Accessible to user contact as determined in accordance with 9.4.3, and

3) Accessible to the rod; or

b) The guard is:

1) Electrically nonconductive material,

2) Accessible to user contact as determined in accordance with 9.4.3,

3) Accessible to the rod, and

4) Required for compliance with the accessibility requirements in 9.4.1.

57 Mounting Means Strength Test

57.1 To determine whether an appliance complies with the requirement in 9.7.1, it is to be mounted in accordance with the installation instructions provided by the manufacturer on a surface of the construction specified using the parts provided. If no surface construction is specified, nominal 3/8 inch (5.3 mm) thick plasterboard (drywall) on nominal 2 by 4 (50.8 by 101.6 mm) inch wood studs spaced on 16 inch (406 mm) centers is to be used as the supporting surface. The mounting parts are to be used as specified in the instructions; and, if not otherwise indicated, the securing screws are to be located between the studs and secured in the plasterboard. An adjustable appliance is to be adjusted to the position that will give the maximum projection from the wall. The force is to be applied through a 3-inch (76-mm) wide strap at the dimensional center of the appliance) and is to be increased during a 5- to 10-second interval, until a load

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equal to the weight of the appliance plus a force of three times the weight of the appliance, but not less than 10 pounds (44.5 N), is applied to the mounting system. The load is to be maintained for 1 minute. The appliance and mounting system are to remain in place with no breakage or rupturing of the support system.

58 Strain Relief Test

58.1 The strain relief means provided on an attached flexible cord or cable, when tested in accordance with 58.2, shall withstand, for 1 minute, a pull of 35 pounds (156 N) applied to the cord.

Exception No. 1: In the case of a partially protected interconnecting cord or cable [see Exception to 20.4.1(a)], the pull applied to the cord shall be 20 pounds (89 N).

Exception No. 2: In the case of a hand-supported appliance weighing no more than 1/2 pound (227 g) exclusive of the cord, the pull applied to the cord shall be 20 pounds.

58.2 The connections of the cord inside the appliance are to be disconnected at the terminals or splices. The specified force is to be applied to the cord and so supported by the appliance that the strain relief means will be stressed from any angle that the construction of the appliance permits. The strain relief is not acceptable if, at the point of disconnection of the conductors, there is sufficient movement of the cord to indicate that stress on the connections would have resulted.

58.3 For the construction mentioned in 16.6.4, six samples of the clamp that have been secured to the cord in the intended manner are to be used. Three unconditioned samples are to be subjected to the dielectric voltage-withstand test specified in 47.1.1 and 47.1.2 by applying the test potential between conductors, and if the clamp is metal, the potential is also to be applied between the clamp and all conductors connected together, and shall then be subjected to the strain relief test specified in 58.1 and 58.2. The remaining three samples shall be tested as described in 58.1 and 58.2 after being subjected to the following procedures:

a) The samples are to be placed for 168 hours in a forced-draft, air-circulating oven maintained at a temperature of 70°C (158°F) or 10°C (18°F) higher than the temperature recorded on the clamp during the Temperature Test, Section 46, whichever is greater.

b) While still in the heated condition, the samples are then to be subjected to the dielectric voltage-withstand test specified in 47.1.1 and 47.1.2. The potential is to be applied between conductors, and if the clamp is metal, the potential is also to be applied between the clamp and all conductors connected together.

c) The conditioned samples then are to be cooled to room temperature.

58.4 With reference to 58.3, in no case shall there be any dielectric breakdown or arc-over, and the strain relief means shall prevent any movement of the cord that could strain the connections. Prior to testing of the oven-conditioned samples, a visual examination shall show no evidence of damage to cord insulation.

59 Torque Test

59.1 A power-supply cord shall withstand for at least 1 minute, a minimum torque of 50 ounce-inches (0.3 N·m) applied about the axis of the cord and at 1 inch (25.4 mm) from the strain relief without damage to the cord and without transmitting the torque to the terminations.

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60 Power-Supply Cord Push-Back Relief Test

60.1 To determine whether means provided to prevent the power-supply cord from being pushed inside the enclosure as described in 16.6.7 is acceptable, the appliance shall be tested as described in 60.2. The construction is not acceptable if any of the following occurs:

a) The cord insulation is subjected to temperatures above its assigned ratings.

b) The cord can come in contact with sharp edges or with moving parts that can damage the conductor insulation.

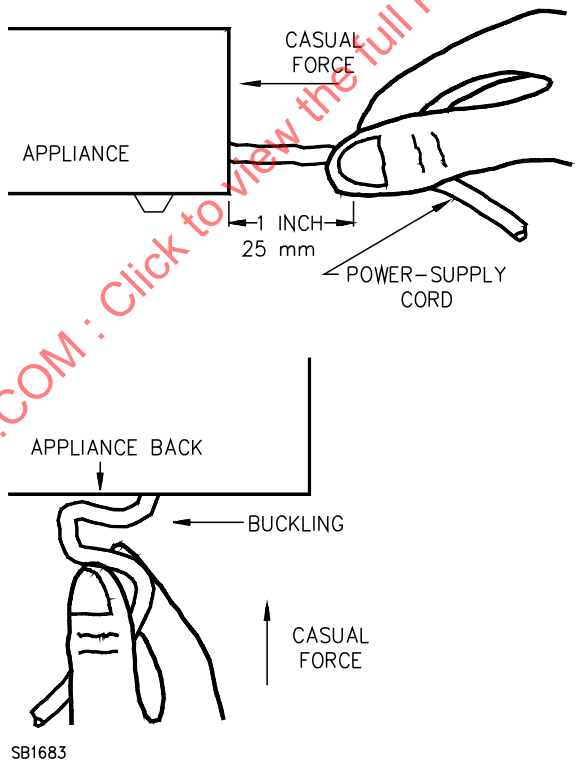
c) The cord displaces parts resulting in a reduction of required spacings.

d) The cord places stress on internal connections.

60.2 The power-supply cord is to be hand held by the fingers 1 inch (25.4 mm) from the point where the cord emerges from the appliance. Then the cord is to be pushed back with casual force. See Figure 60.1. The force is to be applied until the cord is buckled; however, the force is not to exceed 6 pounds (27 N).

Figure 60.1

Power-supply cord push-back investigation



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61 Cord Flexing Test

61.1 Each of six samples of a hand-supported hair dryer, comb, curling iron, untangler, hair-crimping iron, hair-straightening iron, or similar hand-supported appliance shall be subjected to a cord flexing test as described in 61.2.

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61.2 The sample is to be mounted in a guide with a 1/4 pound (113 g) weight attached to the cord 8 inches (203 mm) from the cord entry hole so that the unit can be rotated 540 degrees about the axial center of the cord. A typical arrangement is shown in Figure 61.1. The rate of flexing is to be 10 cycles per minute, where 1 cycle is equivalent to three complete revolutions as defined in footnote a to Table 61.1, resulting in a rotational speed of 30 revolutions per minute. During the test, the supply cord conductors of the sample are to carry current equal to the current rating of the appliance at rated voltage. The samples are to be subjected to the number of cycles of flexing specified in Table 61.1.

Exception No. 1: If agreeable to all concerned, the attached weight may be other than 1/4 pound, adjusted such that the cord is held taut and the intended flexing action is produced.

Exception No. 2: If agreeable to all concerned, the rate of rotation or cycle rate or both may be greater than specified.

Figure 61.1

Cord flexing test apparatus

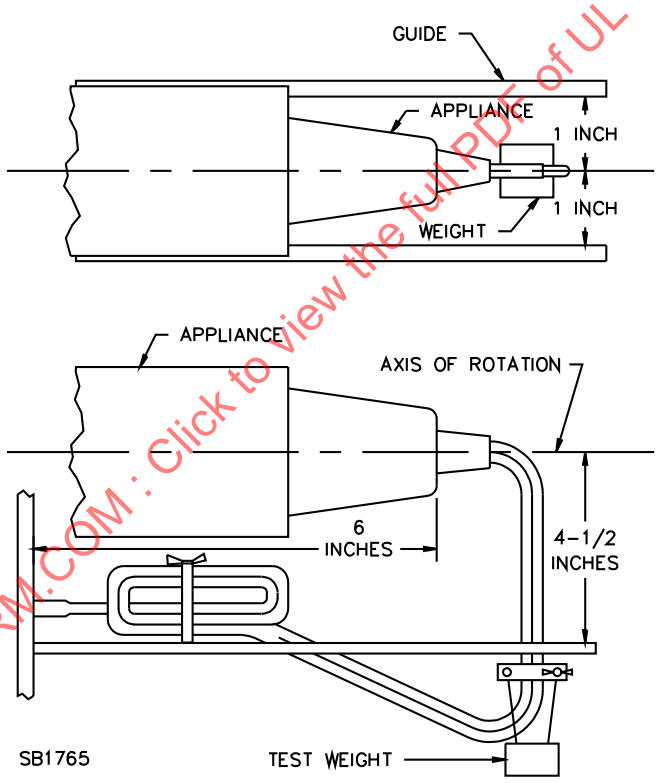

Table 61.1
Number of cycles of operation for cord flexing test

Type of appliance	Cycles required
Hand-supported appliances with or without swivel assemblies	16,000
NOTE – A "cycle" consists of 540 degrees of rotation in one direction plus 540 degrees in the reverse direction back to the starting point.	

61.3 For an appliance employing a cord swivel construction, the test described in 61.2 is to be conducted with the swivel locked in place.

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Exception: An appliance employing a cord swivel construction may be tested with the swivel operating when it complies with 61.5.

61.4 Test results are acceptable if:

a) There is no breakage of the cord or exposure of an uninsulated conductor strand;

b) Each sample is subjected to and complies with a dielectric voltage-withstand test (at a voltage in accordance with the requirements in Table 47.2) between the individual conductors of the flexible cord with the internal connections to the unit severed and insulated; and

c) For an appliance using a 3-conductor, grounding-type cord, the conditions of the ground continuity test specified in 67.1 are met.

61.5 An appliance employing a cord-swivel construction and tested with the swivel operating is to be tested with and without the weight, using separate sets of six samples for each condition, with the cord hanging freely during the test. The swivel shall remain functional during and after completion of the test and shall comply with the requirements in 61.4. A functional swivel serves to keep the cord from rotating past the horizontal plane through the axis of rotation.

62 Test for Security of Swivel Assembly

62.1 The supply swivel assembly on one as-received sample and three conditioned samples (as described in 62.2) are each to be subjected to a direct pull force of 35 pounds (156 N) for 1 minute with the force applied at any angle the construction of the appliance will permit. The appliance is to be operated at rated wattage during this test. The result is acceptable if there is no displacement of the cord and no evidence of intermittent contact in the electrical circuit, and if the appliance complies with the accessibility requirements in 9.4.1 during the test.

Exception: The direct pull force for an appliance weighing 1/2 pound (227 g) or less (exclusive of the cord) is to be 20 pounds (89 N).

62.2 With respect to 62.1, samples are to be conditioned by being maintained for 7 hours at a temperature of 10°C (18°F) higher than the temperature measured on the swivel assembly during the normal temperature test, but not less than 70°C (158°F).

63 Swivel Endurance Test

63.1 An appliance provided with a cord swivel shall be subjected to the cord-swivel endurance test described in 63.2 – 63.6.

63.2 If a hand-supported comb, curling iron, hair untangler, or similar hand-supported appliance is provided with a cord swivel, each of the same six samples subjected to the Cord Flexing Test, Section 61, under the condition of the swivel operating shall be subjected to the tests described in 63.3 and 63.5. For a hand-supported hair dryer provided with a cord swivel, six new samples are to be tested as described in the Exception to 63.3 and in 63.5.

63.3 The cord flexing test as described in 61.2 is to be continued and the swivel is to be cycled for the number of cycles required to accumulate a total of 100,000 cycles. (A cycle consists of 540 degrees in one direction plus 540 degrees in the reverse direction back to the starting point.)

Exception: The cord swivel of a hand-supported hair dryer is to be cycled for a total of 100,000 cycles. A cycle is to consist of 100 degrees in one direction, back to the starting point, then 100 degrees in the reverse direction and back to the starting point. Other test conditions are specified in 61.2.

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63.4 A hand-supported hair dryer that can be converted into a curling iron (for example, by use of a hair-curling attachment) and used as a curling iron is to be cycled in accordance with 63.3 with the appliance in the curling iron configuration, and in accordance with the Exception to 63.3, with the appliance in the hair dryer configuration. A separate set of six samples is to be used for testing in each configuration.

63.5 At the conclusion of the cycling in 63.3, a dielectric voltage-withstand test (at a voltage in accordance with the requirements in Table 47.1) is to be performed, as described in 47.1.1 – 47.1.8, between live parts and exposed surfaces of the swivel assembly.

63.6 Test results are acceptable if:

a) There is no breakage of the cord, or cord swivel, or exposure of an uninsulated conductor strand;

b) Each sample operates as intended;

c) Each sample complies with the requirements of the dielectric voltage-withstand test as required in 63.5; and

d) For an appliance using a 3-conductor grounding-type cord, the conditions of the grounding continuity test specified in 67.1 are met.

64 Hinge Endurance Test

64.1 A hair-crimping iron, a hair-straightening iron, or an appliance having a foldable part, the failure of which may result in the risk of fire, electric shock, or injury to persons, shall be subjected to the hinge endurance test described in 64.2 – 64.4.

64.2 Three samples are to be energized at the voltage specified in 40.2. Each sample of a hair-crimping or hair-straightening iron is then to be subjected to 100,000 cycles of opening and closing of the arms of the appliance. Each sample of an appliance with a foldable part is to be subjected to 30,000 cycles of folding and unfolding of the part. The rate of cycling is to be 10 cycles per minute, with one cycle consisting of closing the moveable part from the fully open position to the fully closed position and then back to the fully open position.

Exception: If agreeable to all concerned, the cycle rate may be greater than specified.

64.3 At the conclusion of the cycling described in 64.2, the Dielectric Voltage-Withstand Test, Section 47, is to be conducted. The test potential is to be applied between live parts and exposed surfaces of the hinge assembly.

64.4 The samples shall complete the required number of cycles without electrical or mechanical failure that would render the appliance inoperable.

a) There shall not be exposure of an uninsulated live part or a normally enclosed insulated wire and

b) Each sample shall comply with the requirements described in the Dielectric Voltage-Withstand Tests, Section 47.

65 Overload Test of Switches and Controls

65.1 A motor control device supplied as a part of an appliance and not having a horsepower rating equivalent to the motor it controls shall be capable of performing acceptably when subjected to an overload test consisting of 50 cycles of operation, making and breaking the stalled rotor current of the

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motor. Electrical or mechanical breakdown of the device or undue pitting or burning of the contacts is unacceptable.

65.2 To determine whether a motor control device complies with the requirement in 65.1, it is to be tested with the appliance connected to a supply circuit of rated frequency, with a voltage in accordance with 40.2, and with the rotor of the motor locked in position. During the test, the frame or enclosure of the appliance is to be connected to ground through a 3-ampere plug fuse, and the electrical connections are to be such that any single-pole, current-rupturing device will be located in an ungrounded conductor of the supply circuit. If the appliance is intended for use on direct current, the exposed dead-metal parts of the appliance are to be so connected as to be positive with respect to a single-pole, current-rupturing device. The performance is acceptable if the fuse in the grounding connection does not open.

66 Automatic Controls Tests

66.1 Overload test

66.1.1 An automatic temperature control provided on an appliance for temperature regulating or limiting shall be capable of operating successfully for 50 cycles of operation when the appliance is connected to a circuit having a voltage of 120 percent of the voltage in accordance with 40.2. The results are acceptable if there is no dielectric or mechanical breakdown of the control, opening of the 3-ampere fuse, or undue burning, pitting, or welding of the contacts.

66.1.2 In a test to determine whether an automatic control complies with the requirement in 66.1.1:

a) The appliance is to be connected to a grounded supply circuit;

b) The enclosure, if of metal, is to be connected to ground through a 3-ampere fuse; and

c) The control, if single-pole, is to be connected in an ungrounded conductor.

An appliance intended for use on alternating current only is to be tested with alternating current; otherwise, the test is to be conducted using direct current.

66.2 Endurance test

66.2.1 Unless it has been shown by previous testing to be acceptable, an automatic temperature control provided on an appliance shall be subjected to an endurance test that shall consist of the number of cycles of operation indicated in Table 66.1, when connected as described in 66.1.2. If it is indicated in the table that the test is to be made under load, the thermostat shall make and break, at a voltage in accordance with 40.2, the maximum rated current that it carries under any condition of intended operation of the appliance. The results are acceptable if there is no dielectric or mechanical breakdown of the thermostat, opening of the 3-ampere fuse, or undue burning, pitting, or welding of the contacts.

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Table 66.1
Number of cycles of operation for endurance test

Type of control	Automatically-reset control	Manually-reset control
Temperature-regulating	A number of cycles equivalent to 1000 hours of intended operation, but not less than 30,000 cycles. However, the test may be omitted if, with the control short-circuited, no temperature rises greater than the values given in Table 46.1 are attained during the temperature test of the appliance.	To be made the subject of an appropriate investigation.[a]
Temperature-limiting	A number of cycles equivalent to 100 hours of operation of the appliance under any condition that causes the control to function, or 100,000 cycles, whichever is greater. However, the test may be omitted if, with the control short-circuited, there is no evidence of a risk of fire as described in 50.1.1 during continuous abnormal operation of the appliance.	1000 cycles under load and 5000 cycles without load. However, the test may be omitted if, with the control short-circuited, there is no evidence of a risk of fire as described in 50.1.1 during continuous abnormal operation of the appliance.
Combination temperature-limiting and -regulating	100,000 cycles if, with the control short-circuited, there is evidence of a risk of fire as described in 50.1.1. If there is no such evidence, the control is to be tested as described for a temperature regulating control.	To be made the subject of an appropriate investigation.[a]
Temperature control for hand-supported hair dryers	6000 cycles. See also 4.47 and 32.2.2.	

[a] If the operation of the control involves physical movement of a part of the appliance, the test is to be so arranged that each cycle will involve the complete intended operation of the appliance.

67 Grounding Continuity Test

67.1 The resistance of the grounding path between any metal part that is required to be grounded (see 38.1.1) and the equipment grounding terminal or lead, or the point of attachment of the wiring system, or the grounding blade of an attachment plug, shall be no more than 0.1 ohm.

67.2 With reference to 67.1, the resistance may be determined by any convenient method. If unacceptable results are recorded, either a direct or alternating current at a potential of not more than 12 volts, and equal to the current rating of the maximum-current-rated branch circuit overcurrent protective device that may be employed with the appliance, is to be passed from:

a) The equipment grounding terminal, or

b) The point of attachment of the wiring system, or

c) The grounding blade of the attachment plug to the dead-metal part.

The resulting drop in potential is to be measured between these two points. The resistance in ohms is to be determined by dividing the drop in potential in volts by the current in amperes passing between the two points.

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68 Test for Permanence of Cord Tag for Hand-Supported, Hair-Drying Appliances

68.1 General

68.1.1 To determine compliance with the permanence requirements of 79.9.2 and 79.9.4, representative samples that have been subjected to the tests described in 68.2.1 – 68.3.1 shall meet the following requirements:

a) The tag shall resist tearing for longer than 1/16 inch (1.6 mm) at any point;

b) The tag shall not separate from the power-supply cord;

c) The tag shall not slip or move along the length of the power-supply cord more than 1/2 inch (12.7 mm);

d) There shall be no permanent shrinkage, deformation, cracking, or any other condition that will render the marking on the tag illegible; and

e) Overlamination shall remain in place and not be torn or otherwise damaged. The printing shall remain legible.

Exception: A cord tag that complies with the applicable requirements in the Standard for Marking and Labeling Systems – Flag Labels, Flag Tags, Wrap-Around Labels and Related Products, UL 969A, under the intended cord surfaces, temperature, specific environmental conditions and limited slippage rating, is not required to comply with this requirement.

68.2 Test conditions

68.2.1 For each type of conditioning mentioned in 68.2.2 – 68.2.4, three samples of the tag applied to the power-supply cord in the intended manner are to be used. If tags are applied by an adhesive, tests are to be conducted no sooner than 24 hours after application of the tag.

68.2.2 Three samples are to be tested as received.

68.2.3 Three samples are to be tested at the end of 30 minutes of conditioning at a room temperature of 23 ±2°C (73.4 ±3.6°F) and 50 ±5 percent relative humidity, following conditioning in an air-circulating oven at 60 ±1°C (140 ±1.8°F) for 240 hours.

68.2.4 Three samples are to be tested within 1 minute after exposure for 72 hours to a humidity of 85 ±5 percent at 32 ±2°C (89.6 ±3.6°F).

68.3 Test method

68.3.1 Each sample is to consist of a length of power-supply cord to which the tag has been applied. The power-supply cord, with the attachment plug pointing up, is to be held tautly in a vertical plane. A force of 5 pounds (22.2 N) is to be applied to the uppermost corner of the tag farthest from the power-supply cord, within 1/4 inch (6.4 mm) of the vertical edge of the tag. The force is to be applied for 1 minute vertically downward in a direction parallel to the major axis of the cord. In determining compliance with 68.1.1(d), manipulation is permissible, such as straightening of the tag by hand. To determine compliance with 68.1.1 (e), each sample is to be scraped 10 times across printed areas and edges, with a force of approximately 2 pounds (8.9 N), using the edge of a 5/64 inch (2.0 mm) thick steel blade held at a right angle to the test surface.

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69 Permanence of Marking Test

69.1 Unless known to be acceptable for the application, a pressure-sensitive label that is required to be permanent (see Markings, Details, Section 79), shall comply with the applicable requirements in the Standard for Marking and Labeling Systems, UL 969.

70 Extended Operation Test

70.1 To determine if a higher temperature than that specified in Table 46.1 is acceptable for a fiberglass sleeving (see footnote g of Table 46.1), three samples of the appliance are to be tested as described in 70.2 – 70.6.

70.2 Each sample is to be operated continuously for 1000 hours. The test voltage (as specified in 40.2) is to be increased, if necessary, to cause the wattage input to the appliance to be equal to its marked wattage rating. Each sample is to be placed on a thermal insulating surface and supported by its stand, if provided. Adjustable temperature controls are to be adjusted for maximum heating. Each sample having an automatically controlled preheat cycle is to be subjected to 30,000 cycles of operation. Each cycle is to consist of energizing the appliance from room temperature to the maximum stabilized temperature condition, then de-energizing and cooling to room temperature. Forced cooling, such as by directing air jets at the appliance, may be used to reduce the cooling time. The "on" time of each cycle is to be such that the total "on" time will be no less than 1000 hours. After the successful completion of the 30,000 cycles of operation or the 1000-hour continuous operation, and after being allowed to cool to room temperature, each sample is to be tested for compliance with the Leakage Current Test, Section 42.

Exception: The appliance is not required to be subjected to the 30,000 cycles of operation if aged for 1000 hours at a temperature equal to the maximum temperature during the preheat cycle.

70.3 Each sample, while at room temperature, is then to be subjected to impacts as described in 70.4 – 70.6. After each drop for a hand-supported appliance and the one impact for other types of appliances, the leakage current test is to be repeated. After the leakage current test, each sample is to be subjected to the Dielectric Voltage-Withstand Test, Section 47. For a hand-supported appliance, the dielectric voltage-withstand test is to be conducted after the final leakage current test.

70.4 Each of three samples of a hand-supported portable appliance is to be dropped 3 feet (0.91 m) to strike a hardwood surface in the position most likely to produce adverse results. The hardwood surface is to be as described in 40.6. Each sample is to be dropped three times so that, in each drop, the sample strikes the surface in a position different from those in the other two drops.

70.5 Stationary, fixed, counter-supported, or floor-supported appliances are to be subjected to the ball impact test described in 70.6.

70.6 Each of three samples of the appliance is to be subjected to a single impact of the value specified in Table 70.1 for the applicable appliance type, on any surface that can be exposed to a blow during normal use. This impact is to be produced by dropping a steel sphere, 2 inches (50.8 mm) in diameter and weighing 1.18 pounds (0.535 kilogram mass) from a height necessary to produce the specified impact as shown in Figure 70.1. For surfaces other than the top of an enclosure, the steel sphere is to be suspended by a cord and swung as a pendulum, dropping through the vertical distance necessary to cause it to strike the surface with the specified impact as shown in Figure 70.1.

70.7 The results are acceptable if all samples comply with the Leakage Current and Dielectric Voltage-Withstand Tests, Sections 42 and 47, respectively.

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