UL 1083

STANDARD FOR SAFETY

Household Electric Skillets and Frying-Type Appliances

UL Standard for Safety for Household Electric Skillets and Frying-Type Appliances, UL 1083

Sixth Edition, Dated January 9, 2009

Summary of Topics

This revision to ANSI/UL 1083 dated March 3, 2023 includes UL 969A as an Alternative to Existing Permanency of Marking Requirements for Cord Tags; Section 50 title, 50.1.1, 50.2.1, 54.14, and 56.11.

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated June 10, 2022 and January 20, 2023.

No Text on This Page

JANUARY 9, 2009
(Title Page Reprinted: March 3, 2023)

ANSI/UL 1083-2023

UL 1083

Standard for Household Electric Skillets and Frying-Type Appliances

First Edition – April, 1973
Second Edition – November, 1979
Third Edition – August, 1987
Fourth Edition – July, 1995
Fifth Edition – August, 2002

Sixth Edition

January 9, 2009

This ANSI/UL Standard for Safety consists of the Sixth Edition including revisions through March 3, 2023.

The most recent designation of ANSI/UL 1083 as an American National Standard (ANSI) occurred on March 3, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 1083 on October 20, 2010. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

No Text on This Page

CONTENTS

INTRODUCTION

CONSTRUCTION

PERFORMANCE

MANUFACTURING AND PRODUCTION TESTS

RATINGS

MARKINGS

INSTRUCTIONS

APPENDIX A

APPENDIX B

No Text on This Page

INTRODUCTION

1 Scope

1.1 These requirements cover portable electric household skillets and other frying-type appliances, rated at 125 V or less, for use in ordinary locations in accordance with the National Electrical Code, NFPA 70.

1.2 Frying-type appliances in this standard include frying-pans, sauce-pans, griddles, corn poppers, deep fryers, oil fondues, low temperature fondues, tempuras, woks, waffle makers, sandwich makers, contact grills, and other similar appliances which may or may not be thermostatically controlled.

1.2.1 These requirements do not cover skillets or frying-type appliances with marked capacities of more than 5.3 quarts (5 liters) of cooking oil.

1.3 These requirements do not cover skillets or frying-type appliances intended for outdoor use, warming trays, or appliances that are covered in individual requirements that are separate from this standard.

1.4 In the following text, a requirement which applies to one type of equipment coming within its scope (skillet, waffle-maker, and the like) will be so identified by a specific reference in that requirement to the type of equipment involved. In the absence of such specific reference or if the term "appliance" is employed, it is to be understood that the requirement applies to all of the types of equipment covered by the standard.

1.5 A heating appliance covered by this Standard and intended to cook with oil to a depth greater than 0.5 inches (13 mm) during normal operation shall be subjected to the additional requirements for Deep Fryers / Cooker Fryers / Oil Fondues specified in this Standard.

2 Components

Section 2 deleted

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 Units of Measurement

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

4.2 Unless indicated otherwise, all voltages and current values mentioned in this Standard are root-mean-square (rms).

5 Glossary

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

5.1.1 COOKER / FRYER – An adjustable thermostatically controlled heating appliance intended to cook at various temperature levels. One of the functions is as a deep fryer.

5.1.2 DEEP FRYER – A thermostatically controlled heating appliance intended to cook food loads submerged in hot oil. The appliance is intended to have an oil depth greater than 0.5 inches (13 mm) during normal operation.

5.1.3 FRYING PAN, FRYPAN, SKILLET – A heating appliance having a flat pan with flared or straight sides intended to cook with an amount of oil, 0.5 inches (13 mm) or less as measured from the center of the pan, for frying, searing, or browning foods.

5.1.3.1 LARGE ITEM – As applied to a Deep Fryer or Cooker/Fryer, an individual food item weighing 5 lbs (2.27 kg) or more intended to be cooked whole.

5.1.4 LOW TEMPERATURE FONDUE – A heating appliance intended to cook or warm melted cheese, chocolate, or other liquid sauces. The maximum obtainable temperature of the food medium does not exceed 110°C (230°F) and does not advertise the use as an oil fondue.

5.1.5 OIL FONDUE – A heating appliance intended to cook various food loads while submerged in hot oil to a depth greater than 0.5 inches (13 mm) during normal operation.

5.1.6 WOK – A heating appliance having a round curved bottomed cooking pan used with an amount of oil filled to a depth of 0.5 inches (13 mm) or less, for stir frying.

5.2 TEMPERATURE-REGULATING THERMOSTAT – A thermostat that functions only to regulate the temperature of the heating appliance under normal conditions of use, and whose malfunction would not result in a risk of fire.

5.3 TEMPERATURE-LIMITING THERMOSTAT– A thermostat that functions only under conditions that produce abnormal temperatures. The malfunction of such a thermostat might not result in a risk of fire.

5.4 TEMPERATURE-REGULATING AND -LIMITING THERMOSTAT– A thermostat that functions to regulate the temperature of the heating appliance under normal conditions of use, and also serves to prevent a fire that may result from conditions of abnormal operation of the appliance.

5.5 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).

5.6 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.

5.7 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.

5.8 COMPONENT – A device or fabricated part of the appliance covered by the scope of a safety standard dedicated to the purpose. When incorporated in an appliance, equipment otherwise typically field installed (e.g. luminaire) is considered to be a component. Unless otherwise specified, materials that compose a device or fabricated part, such as thermoplastic or copper, are not considered components.

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

5.10 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.

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

5.12 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.

5.13 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 normal and reasonably anticipated abnormal operation of the appliance. For example, a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control. (During the testing of the protective control/circuit, the protective functions are verified under normal and single-fault conditions of the control.)

5.14 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.

5.15 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.

5.16 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.

CONSTRUCTION

6 General

6.1 Only materials that are intended for the particular use shall be used in an appliance. It shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

6.2 A component of a product covered by this Standard shall:

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

b) Be used in accordance with its rating established for the intended conditions of use;

c) Be used within its established use limitations or conditions of acceptability;

d) Additionally comply with the applicable requirements of this end product 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 in the National Electrical Code, 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.

6.3 A component that is also intended to perform other functions, such as over current protection, ground-fault circuit-interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable UL standard that cover devices that provide those functions.

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

6.4 A component not anticipated by the requirements of this end product 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 6.2 (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 end product Standard.

7 Frame and Enclosure

7.1 The frame and enclosure of an appliance shall be strong and rigid enough to resist the abuses likely to be encountered during normal 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 serious defects which alone or in combination constitute an increase in the risk of fire, electric shock, or injury to persons.

7.2 An appliance shall be provided with an enclosure of material acceptable for the particular application, which shall house all electrical parts, except a supply cord that may present a risk of fire, electric shock, or injury to persons under any condition of use.

7.3 In the case of an appliance employing oil or grease in its cooking operation, special consideration is to be given to the need for an enclosure over the cooking compartment, and to the acceptability for the purpose of the material employed for such an enclosure.

7.4 Among the factors that shall be taken into consideration when an enclosure is being judged 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.

A nonmetallic enclosure shall comply with the enclosure requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. A metal enclosure or enclosure part shall be tested in accordance with Metal Enclosure Impact Tests, Section 36, for resistance to impact.

Exception No. 1: When considering the abnormal and severe conditions tests of UL 746C, the appliance enclosure is to be judged under the abnormal operations tests of Abnormal Operation Test, Section 46.

Exception No. 2: Thermoset materials need not be subjected to the relative thermal capability requirements of UL 746C. For a thermoset material operating at a temperature above its temperature rating, the 1000 hour aging test as specified in 43.1 shall be conducted.

7.5 A thermoplastic enclosure of an appliance provided with overheating protection (Overheating Protection, Section 22) need not comply with the flammability requirements of UL 746C if a material rated HB, and possessing 60 arcs minimum resistance to high current arc ignition, and 7 second minimum resistance to hot wire ignition is employed and all enclosure parts including ribs, grills, and the like are spaced a minimum 1/2 inch (12.7 mm) from uninsulated live parts.

7.6 Cast- and sheet-metal portions of the enclosure shall be no thinner than indicated in Table 7.1 unless the enclosure is found to be acceptable when judged under considerations such as mentioned in 7.4.

Table 7.1
Minimum acceptable thicknesses of enclosure metal

Metal	At small, flat, unreinforced surfaces and at surfaces that are reinforced by curving, ribbing, or the like or are otherwise of a shape and/or size to provide equivalent physical strength		At relatively large unreinforced flat surfaces	
	Inches	(mm)	Inches	(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[a])	0.026	(0.66)

Table 7.1 Continued on Next Page

Table 7.1 Continued

Metal	At small, flat, unreinforced surfaces and at surfaces that are reinforced by curving, ribbing, or the like or are otherwise of a shape and/or size to provide equivalent physical strength		At relatively large unreinforced flat surfaces	
	Inches	(mm)	Inches	(mm)
Galvanized sheet steel	0.029[a]	(0.74[a])	0.029	(0.74)
Nonferrous sheet metal	0.036[a]	(0.91[a])	0.036	(0.91)

[a] Thinner sheet metal may be employed if found to be acceptable when the enclosure is judged under considerations such as those mentioned in 7.4.

7.7 Electrical parts of an appliance, except the radiating portion of an open-wire element of a waffle-maker-type appliance with removable grids and its terminal connections immediately adjacent to the radiating element, shall be located or enclosed so that protection against unintentional contact with uninsulated live parts is provided.

7.8 The enclosure shall be constructed so that molten metal, burning insulation, flaming particles, or the like does not fall on the supporting surface.

7.9 The requirement in 7.8 necessitates that an enclosure bottom with an opening be provided with a barrier above or below the opening if the opening is:

a) Under a motor unless:

1) The structural parts of the motor or of the appliance provide the equivalent of such a barrier;

2) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the appliance when the motor is energized under each of the following fault conditions:

i) Open main winding;

ii) Open starting winding;

iii) Starting switch short-circuited; and

iv) For a permanent-split-capacitor motor the capacitor is short circuited. The short circuit is to be applied before the motor is energized and the rotor is to be blocked.

3) The motor is provided with a thermal motor protector (a protective device that is sensitive to both temperature and current) that prevents the temperature of the motor windings from becoming more than 125°C (257°F) under the maximum load under which the motor runs without causing the protector to cycle, and from becoming more than 150°C (302°F) with the rotor of the motor locked; or

4) The motor complies with the requirements for impedance-protected motors.

b) Under wiring, unless the wiring complies with the VW-1 flame test or the Vertical Flame Test described in the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

c) Under an unenclosed switch, transformer, relay, solenoid, and the like, unless it can be shown that malfunction of the component is not likely to result in a fire.

d) Under field and factory-made splices and overload and overcurrent protective devices.

Exception: A barrier is not required if the opening is not within the area under the component requiring a barrier as illustrated by Line D in Figure 7.1.

7.10 The barrier mentioned in 7.9 shall be:

a) Of metal, ceramic, or a material that is acceptable as an enclosure in accordance with 7.4;

b) Horizontal; and

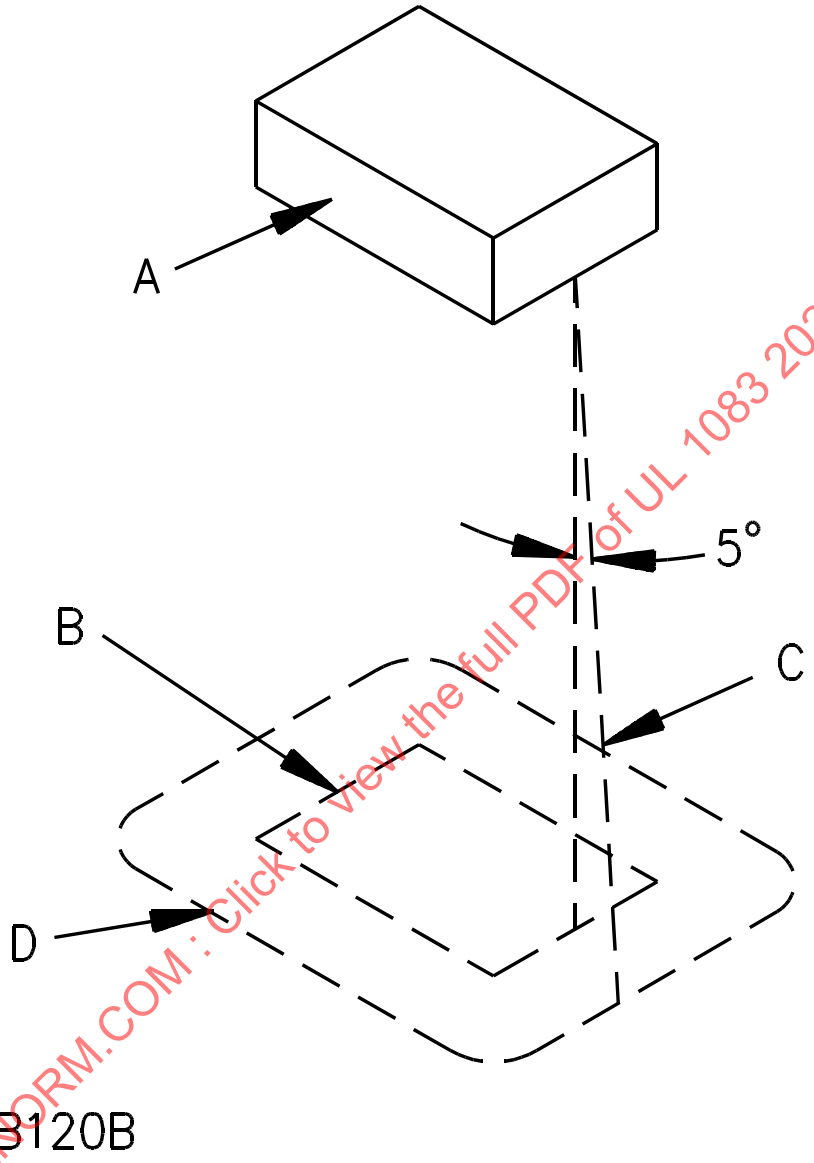
c) Located as indicated in Figure 7.1, and shall not have an area less than that described in Figure 7.1.

7.11 An opening in the enclosure that has a minor dimension of less than 1 inch (25.4 mm) is acceptable if a probe as illustrated in Figure 7.2, inserted through the opening, cannot be made to touch any uninsulated live part or film-coated wire that involves the risk of electric shock. The probe shall be applied in all possible articulated positions before, during, and after insertion.

7.12 An opening that has a minor dimension of 1 inch (25.4 mm) or more, in an enclosure, as illustrated in Figure 7.3, is acceptable if, within the enclosure, there is no uninsulated live part or film-coated wire less than, R distance from the inside edge of the perimeter of the opening and X distance from the plane of the opening. T equals the enclosure thickness, R equals X minus T, and X equals five times the diameter of the largest round rod that can be inserted through the opening but not less than 6-1/16 inches (154 mm). In evaluating an opening, any barrier located within the volume is to be ignored unless it intersects the boundaries of the volume in a continuous, closed line.

Figure 7.1

Location and extent of barrier



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

B – Projection of outline of component on horizontal plane.

C – Inclined line that traces out minimum area of barrier. The line is always:

1) Tangent to the component;

2) 5 degrees from the vertical; and

3) 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.

Figure 7.2

Accessibility probe

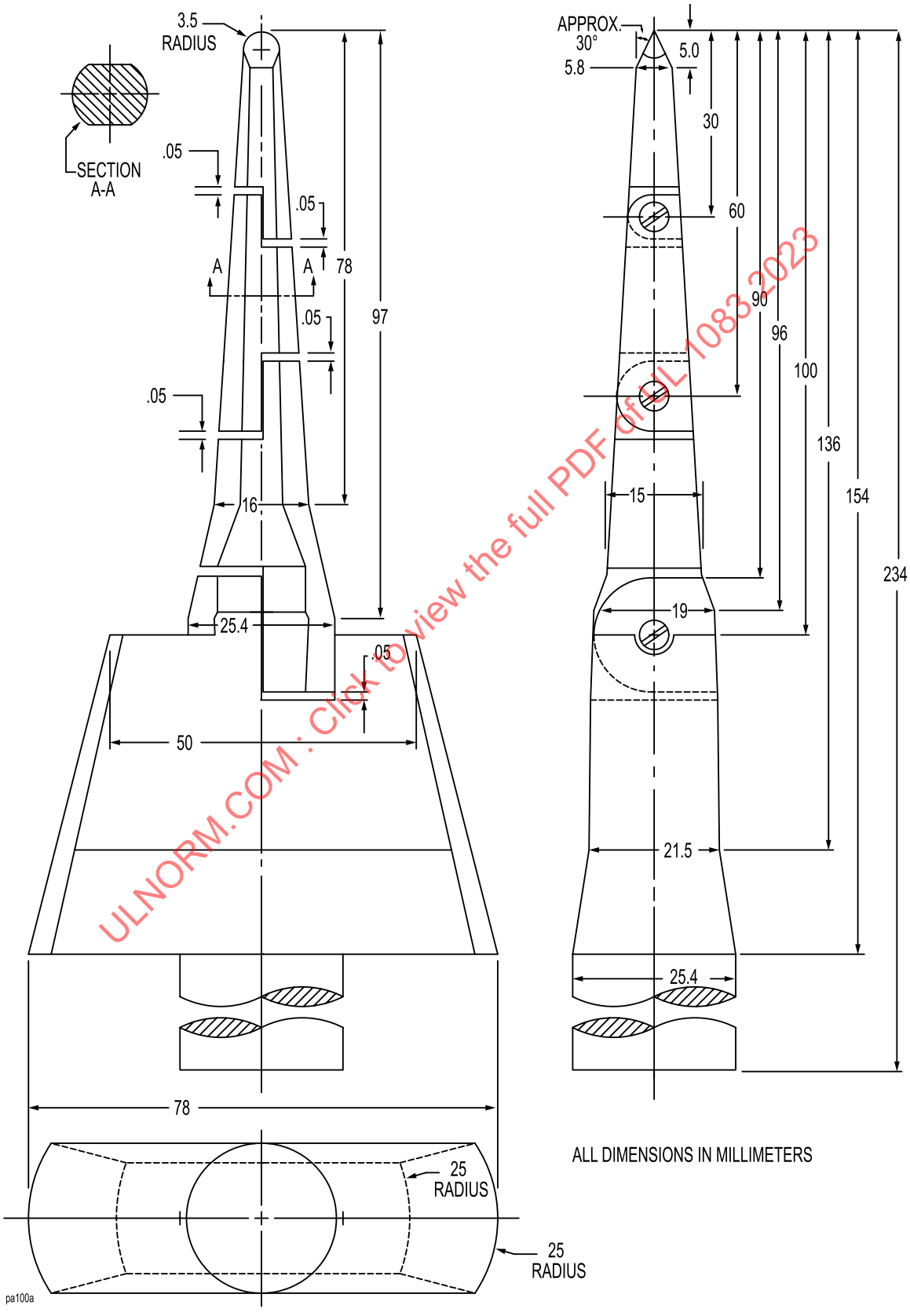
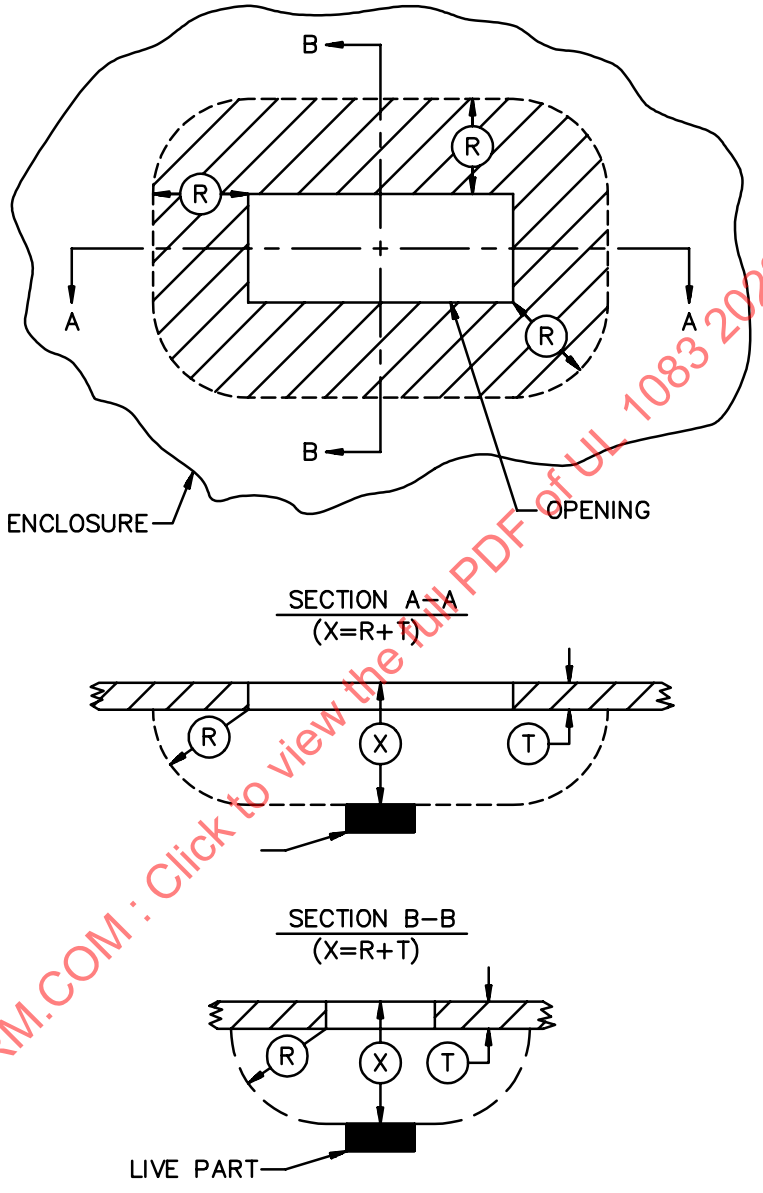


Figure 7.3

Opening in enclosure
proportions exaggerated for clarity



SB0610–1

7.13 If a marking draws attention of the user to a hole of any size in the enclosure for the adjustment of a thermostat or for a similar activity, it shall not be possible to damage insulation or contact uninsulated live parts through the hole with a 1/16-inch diameter rod (1.6 mm).

7.14 During the examination of an appliance in accordance with the requirements in 7.7 and 7.10 – 7.13, any part of the enclosure is to be disregarded – that is, it shall not be assumed that the part in question affords protection against electric shock or injury to persons – if it either:

a) Must be opened or removed, with or without the use of tools, to perform manufacturer's recommended user servicing, maintenance, operating adjustments, attachment of accessories, or other instructions; or

b) Can be opened or removed without the use of tools.

Exception: A part that requires a tool for opening or removal to perform manufacturer's recommended user servicing, maintenance, operating adjustments, attachment of accessories, or other instructions is to remain in place if the appliance is marked in accordance with 54.6.

7.15 A component of an appliance that is likely to need inspection, replacement, cleaning, or other servicing shall be as accessible as possible. The component shall be readily accessible without the use of special tools (tools not available to other than service personnel) if it is intended to be manually operated or adjusted or periodically serviced.

7.16 A deep fryer shall be constructed so that spillage of the hot oil on the heating element is prevented.

7.17 The bulb and capillary tube of a thermostat shall be protected from mechanical damage if damage of the tube or bulb increases the risk of fire.

7.18 A 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.

8 Assembly

8.1 A switch, lampholder, attachment-plug receptacle, or plug-type connector provided as a part of an appliance shall be mounted securely and prevented from turning by means other than friction between surfaces.

8.2 A lock washer properly applied is acceptable as a means to prevent turning of a stem-mounted switch.

8.3 Uninsulated live parts shall be secured to the base or surface so that they are prevented from turning or shifting in position as the result of stresses if such motion may result in a reduction of spacings below the minimum required in 21.1.1 and 21.1.2.

8.4 Friction between surfaces is not acceptable as a means to prevent shifting or turning of live parts, but a properly applied lock washer is acceptable.

8.5 Unless determined to be acceptable for the purpose, fastening of the handle assembly of a deep fryer, cooker/fryer, or any fondue appliance shall not rely on cement or equivalent materials alone. Mechanical means, such as pressure clamping, bosses and lances, and the like, shall be provided.

8.6 A handle assembly that is utilized to lift and tilt a deep fryer, cooker/fryer, or oil fondue appliance shall comply with the requirements in 8.7 – 8.10, Table 31.1, and Sections 40 and 41.

8.7 A nonmetallic handle or feet of a deep fryer, cooker/fryer, or oil fondue appliance shall be identified as required by the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

8.8 A handle of a deep fryer, cooker/fryer, or oil fondue appliance shall be fastened so that a positive stop, interference screw or rivet, or other arrangement is provided so that with minor loosening, disengagement of the handle from the vessel does not result.

8.9 Iron and steel parts of a handle assembly of a deep fryer, cooker/fryer, or oil fondue appliance shall be provided with corrosion protection in accordance with 9.1 or shall be constructed of stainless steel or other noncorrosive metal acceptable for the application.

8.10 A handle of a deep fryer, cooker/fryer, or any fondue appliance secured by a single fastening means shall be prevented from rotating by means other than friction. A lockwasher alone is not acceptable.

8.11 The feet of a deep fryer, cooker/fryer, or oil fondue appliance shall comply with Deep Fryer, Cooker/Fryer, and Fondue Cycling Test, Section 40.

9 Corrosion Protection

9.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means, if the malfunction of such unprotected parts increases the risk of fire or electric shock.

Exception: Where the oxidation of steel is not likely to be accelerated due to the exposure of metal to air and moisture or other oxidizing influence – thickness of metal and temperature also being factors – surfaces of sheet steel within an enclosure may not be required to be protected against corrosion. Cast-iron parts are not required to be protected against corrosion. A sheath employed on a heating element operating in air and terminal parts attached directly to the heating element need not be protected against corrosion.

9.2 The aging characteristics of plating or other finish used in an appliance shall be such that deterioration of the finish will not result eventually in unacceptable performance of the appliance.

10 Supply Connections

10.1 General

10.1.1 An appliance shall be provided with a length of attached flexible cord and an attachment plug for connection to the supply circuit, or shall have male pin terminals that accommodate a detachable power-supply cord. The length of attached cord or detachable power-supply cord shall not be less than 2 ft (0.6 m), nor greater than 7 ft (2.1 m).

10.1.2 A deep fryer, cooker/fryer, and oil fondue appliance shall be provided with a detachable power-supply cord having a cord length a minimum of 2 ft (0.6 m) and a maximum of 3 ft (0.9 m) long.

10.1.3 An appliance provided with a detachable power-supply cord or nondetachable power-supply cord less than 4-1/2 ft (1.4 m) in length shall be provided with instructions in accordance with 56.11.

10.1.4 If a flexible cord or detachable power-supply cord is provided with an appliance, the rating (both current and voltage) of the cord and the fittings shall not be less than that of the appliance.

10.1.5 An attached flexible cord or a detachable power-supply cord that is provided with an appliance shall be Type HPD, HPN, HSJ, or HSJO or shall have such properties that it is at least equally as serviceable for the particular application.

10.1.5.1 A cord set or power supply cord shall comply with the Standard for Cord Sets and Power-Supply Cords, UL 817.

10.1.5.2 Flexible cords and cables shall comply with the Standard for Flexible Cords and Cables, UL 62. Flexible cord and cables are considered to fulfill this requirement when preassembled in a cord set or power supply cord complying with the Standard for Cord Sets and Power-Supply Cords, UL 817.

10.1.6 A 3- to 2-wire, grounding-type adapter shall not be provided with an appliance.

10.1.7 Supplementary insulation, if employed on a flexible cord, shall not extend more than 1/2 inch (13 mm) outside the appliance (unless provided with additional mechanical protection), shall be prevented from fraying or unraveling and shall not affect adversely the means for providing strain relief.

10.1.8 The attachment plug of the power-supply cord of an appliance provided with a 15- or 20-ampere general use receptacle shall be of the 3-wire grounding type. The attachment plug of the power-supply cord of an appliance provided with a manually operated, line-connected, single pole switch for appliance on-off operation or an Edison-base lampholder shall be of the polarized or grounding type.

10.1.8.1 Attachment plugs, receptacles, appliance couplers, appliance inlets (motor attachment plugs), and appliance (flatiron) plugs, shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

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.

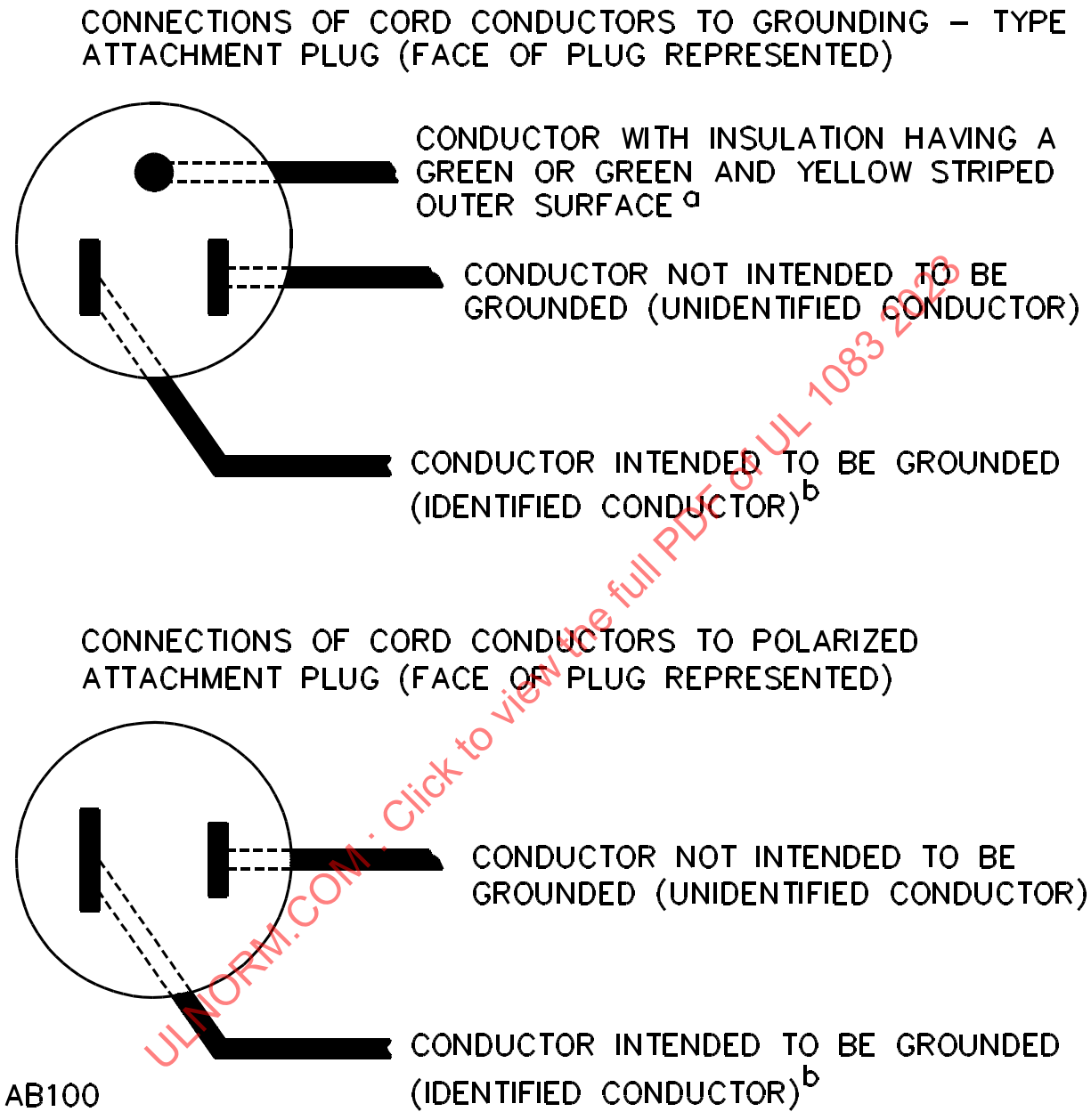
Exception No. 2: A fabricated pin terminal assembly need not comply with UL 498 if it complies with Frame and Enclosure, Section 7; Assembly, Section 8; Current-Carrying Parts, Section 11; and Spacings, Section 21, of this end product Standard.

10.1.8.2 Female devices (such as receptacles, 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.

10.1.9 If a 3-wire grounding-type attachment plug or a 2-wire polarized attachment plug is provided, the attachment plug connection shall comply with Figure 10.1 and the polarity identification of the flexible cord shall comply with Table 10.2.

Figure 10.1

Connections 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 10.2.

10.1.10 The conductor of the power-supply cord that is intended to be grounded shall have the following items 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 10.2 identifies the supply cord conductor intended to be grounded.

10.2 Strain relief

10.2.1 Strain relief shall be provided to prevent a mechanical stress on an attached flexible supply cord from being transmitted to terminals, splices, or interior wiring.

10.2.1.1 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) may still need to be performed to confirm the combination of the insulating bushing and the supporting part are suitable.

10.2.2 If wood, pressed board, or other fibrous materials is used to secure the strain-relief assembly, the fibrous material shall be secured to the appliance by a pin, setscrew, or other positive means.

10.2.3 Means shall be provided to reduce the likelihood of an attached supply cord or lead from being pushed into the enclosure of an appliance through the cord-entry hole. To determine compliance with this requirement, the supply cord or lead shall be tested in accordance with Push-Back Relief Test, Section 35.

10.2.4 If a knot serves as strain relief in an attached flexible cord, any surface with which the knot may come in contact shall be free from projections, sharp edges, burrs, fins, and the like, which may cause abrasion of the insulation on the conductors.

10.3 Pin terminals

10.3.1 If an appliance is provided with pin terminals, the design of the appliance shall be such that no live parts are exposed to unintentional contact both during and after the placement of the plug on the pins, in the intended manner.

10.3.2 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 7.2 should not touch any current-carrying pin while the probe is inserted through any opening with the appliance in any position.

10.3.3 The plug used in accordance with 10.3.2(b) shall be the plug supplied with the appliance.

10.3.4 If an appliance employs three or more pin terminals intended for use with a plug that covers all the pins, the terminals shall be spaced so that they do not accommodate a flatiron or appliance plug or cord-connected body. The plug that these pins accommodate shall be appropriate for the particular application.

10.3.5 If an appliance is provided with a user removable heating element, the heating element shall have a guard that shall:

a) Be securely and rigidly mounted by means other than friction alone; and

b) Prevent the heating element pins from being damaged, shorting to the appliance enclosure during insertion or removal, and shifting in position relative to each other.

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

10.3.7 The requirement in 10.3.6 is intended primarily to provide for the maintenance of spacings as given in 21.1.1 and to provide for the maintenance of proper spacings between pin terminals. Under this requirement, consideration shall also be given to the means for locking terminals in position to maintain tightness.

10.3.8 The dimensions of pins and their center-to-center spacings (including the corresponding spacings of the female contacts of general-use plugs that these arrangements of pins will accommodate) are as indicated in Table 10.1.

Table 10.1
Pins of appliance and flatiron plugs

Type and rating of plug that accommodates the pins	Configuration of pins			Dimensions of pins	
	Number	Arrangement	Spacing between centers, inch (mm)	Diameter, inch (mm)	Length, inch (mm)
Appliance plug rated 10 A at 125 V	2	In line	1/2 (12.7)	0.156 ±0.005 (4.0±0.13)	9/16 – 5/8 (14.3 – 15.9)
Flatiron plug rated 10 A at 125 V	2	In line	11/16 (17.5)	0.188 ±0.005 (4.8 ±0.13)	3/4 – 7/8 (19.0 – 22.2)
Jumbo appliance plug rated 15 A at 125 V and	2	In line	1-1/16 (27.0)	0.188 ±0.005 (4.8 ±0.13)	3/4 – 7/8 (19.0 – 22.2)
Reversible plug (for two-heat control) rated 15 A at 125 V[a]	3	In line	7/8 (22.2)	0.188 ±0.005 (4.8 ±0.13)	3/4 – 7/8 (19.0 – 22.2)
Reversible plug (for two- or three-heat control) rated 15 A at 125 V[a]	3	One pin at apex of an equilateral triangle	7/8 (22.2)	0.188 ±0.005 (4.8 ±0.13)	3/4 – 7/8 (19.0 – 22.2)

[a] Usually this plug is made without a contact in one of the holes.

Table 10.2
Polarity identification of flexible cords

Method of identification	Acceptable combinations		
	Wire intended to be grounded[d]		All other wires[d]
Color of braids on individual conductors	A	Solid white or gray – without tracer	Solid color other than white or gray – without tracer
	B	Color other than white or gray, with tracer in braid	Solid color other than white or gray – without tracer
Color of insulation on individual conductors	C[a]	Solid white or gray	Solid color other than white or gray
	C1[e]	Light blue	Solid color other than light blue, white or gray
Color separators	D[b]	White or gray	Color other than white or gray

Table 10.2 Continued on Next Page

Table 10.2 Continued

Method of identification	Acceptable combinations		
	Wire intended to be grounded[d]		All other wires[d]
Other means	E[c]	Tin or other white metal on all strands of the conductor	No tin or other while metal on the strands of the conductor
	F[b]	A stripe, ridge, or groove on the exterior surface of the cord	

[a] Only for cords–other than Type SP-1, and SPT-1–having no braid on any individual conductor.

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

[c] Only Type SPT-1, and SPT-2 cords.

[d] A wire finished to show a green color with or without one or more yellow stripes or tracers is to be used only as an equipment grounding conductor. See 23.1 and Figure 10.1.

[e] For jacketed cord.

10.3.9 An appliance provided with three pin terminals, one of which is for grounding, shall not be provided with or capable of being used with a two-conductor detachable power-supply cord.

10.3.10 An appliance provided with two pin terminals shall not be provided with or capable of being used with a three-conductor detachable power-supply cord employing a grounding conductor.

10.4 Bushings

10.4.1 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be an acceptable bushing or the equivalent that shall be substantial, reliably secured in place, and shall have a smooth, well-rounded surface against which the cord may bear. If Type HPN flexible cord or lighter is employed, if the wall or barrier is of metal, and if the construction is such that the cord may be subjected to strain or motion, an insulating bushing shall be provided. The heat- and moisture-resistant properties of the bushing material shall be such that the bushing is acceptable for the particular application.

10.4.1.1 In addition to the requirements in 10.4.1, Insulating bushings shall comply with the Standard for Insulating Bushings, UL 635.

10.4.2 If the cord hole is in porcelain, phenolic composition, or other nonconducting material, a smooth, well-rounded surface is considered to be equivalent to a bushing.

10.4.3 Ceramic materials and some molded compositions are acceptable generally for insulating bushings, but a separate bushing of wood, hot-molded shellac and tar composition, or rubber material is not acceptable. Vulcanized fiber may be employed if the bushing is not less than 3/64 inch (1.2 mm) thick, and if it is so formed and secured in place that it is not affected adversely by conditions of ordinary moisture.

10.4.4 An insulated metal grommet may be accepted in place of an insulating bushing if the insulating material used is not less than 1/32 inch thick (0.8 mm), and completely fills the space between the grommet and the metal in which it is mounted.

11 Current-Carrying Parts

11.1 Each current-carrying part shall be made of metal that is appropriate for the particular application.

11.2 Current-carrying parts made of corrosion-resistant alloys (for example, stainless steel) are acceptable regardless of temperature. Current-carrying parts made of ordinary iron and steel are not

acceptable unless they are rendered corrosion-resistant by an appropriate coating and, even then, they are acceptable only as follows:

a) Pin terminals;

b) Parts whose normal operating temperature is higher than 100°C (212°F);

c) Parts of a component that the requirements referred to in 6.2 – 6.5, indicate as being acceptable with coated iron and steel parts.

11.3 If a reservoir is part of a heating appliance, all live parts shall be located or projected so that they are not subject to dripping if the reservoir leaks, unless:

a) The reservoir is resistant to corrosion from the liquid intended for use in it; and

b) The reservoir does not develop cracks as a result of aging.

12 Internal Wiring

12.1 General

12.1.1 The internal wiring of an appliance shall consist of wires of adequate size and of a type or types which are appropriate 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 or grease; and

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

12.1.2 There is no temperature limit applicable to unimpregnated glass fiber, beads of inorganic material, or the equivalent employed as conductor insulation.

12.1.3 *Deleted*

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

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; or

c) The applicable UL standard for other insulated conductor types specified in Wiring Methods and Materials, of the National Electrical Code, 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.

12.2 Protection of wiring

12.2.1 The wiring and connections between parts of a waffle-maker-type appliance shall be protected or enclosed, except that a length of flexible cord may be employed for external connections, or for internal

connections that may be exposed during servicing, if flexibility of the wiring is essential. A bare conductor or a conductor with beads for insulation shall not be used outside an enclosure.

12.2.2 Internal wiring that is exposed through an opening in the enclosure of a waffle-maker-type appliance is considered to be protected as required in 12.2.1 if, when judged as if it were enamel-insulated wire, the wiring is acceptable according to 7.7 – 7.11. Internal wiring not so protected may be accepted if it is secured within the enclosure so that it is unlikely to be subjected to stress or mechanical damage.

12.2.3 If the wiring of an appliance is located so that it is in proximity to combustible material or may be subjected to mechanical injury, it shall be protected.

12.2.4 Wires within an enclosure, compartment, raceway, or the like shall be located or protected so that damage to conductor insulation can not result from contact with any rough, sharp, or moving part.

12.2.5 A hole by means of which insulated wires pass through a sheet-metal wall within the overall enclosure of an appliance shall be provided with a smooth, well-rounded bushing or shall have smooth, well-rounded surfaces upon which the wires may bear, to prevent abrasion of the insulation.

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

12.2.7 Wire positioning devices shall comply with the requirements in Electrical Insulation, Section 14. A device that complies with the Standard for Positioning Devices, UL 1565, is considered to comply with this requirement.

12.3 Splices

12.3.1 All splices and connections shall be mechanically secure and shall provide good electrical contact. A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection may result in a risk of fire or electric shock.

Exception: Printed-wiring board joints need not be mechanically secure before soldering.

12.3.2 A splice shall be provided with insulation equivalent to that of the wires involved if permanence of spacings between the splice and other metal parts of the appliance is not reliably maintained.

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

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

12.3.5 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.

12.3.6 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 in), 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.

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

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

12.3.9 Single and multi-pole 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 Use in Data, Signal, Control and Power Applications, UL 1977.

12.3.10 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.

12.3.11 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.

12.3.12 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 Current-Carrying Parts, Section 11; Electrical Insulation, Section 14; and Spacings, Section 21, of this end product Standard. This exception does not apply to protective conductor terminal blocks.

13 Heating Elements

13.1 A heating element shall be adequately supported. It shall be protected against mechanical damage and contact with outside objects.

13.2 In determining that a heating element is adequately supported, consideration shall be given to sagging, loosening, and other adverse conditions of the element resulting from continuous heating. For an open-wire (uninsulated resistance wire) heating element, consideration shall also be given to breakage at any point.

13.3 Except for a waffle baker grill with removable grids (see 18.3 and 20.1), a heating element in an appliance which may be contacted by the user during use or cleaning shall not be of the open-wire construction.

13.4 An open-wire element, or uninsulated resistance wire, may be used in an appliance provided it is enclosed or protected by barriers or covers that require tools for removal, and it complies with the accessibility of live parts requirements outlined in 7.7 and 7.11 – 7.14 and the broken element test of Broken Element Test, Section 45.

13.5 A sheathed element, rope heater, or the like shall be judged under the applicable requirements of this Standard.

13.5.1 Heating wire (e.g. rope heater) that complies with the Standard for Appliance Wiring Material, UL 758, and the requirements of this end product Standard are considered to fulfill this requirement.

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

14 Electrical Insulation

14.1 Insulating washers, bushings, and the like, which are integral parts of a heating appliance and bases or supports for the mounting of current-carrying parts shall be of a moisture-resistant material which is not damaged by the temperatures to which it is subjected under conditions of actual use. Molded parts shall be constructed so that they have adequate mechanical strength and rigidity to withstand the stresses of actual service.

14.2 Insulating material employed in an appliance shall be judged with respect to its acceptability for the particular application. Materials such as mica, some molded compounds, and certain refractory materials are usually acceptable for use as the direct support of live parts. Other materials which are not acceptable for general use, such as magnesium oxide, may be acceptable if used in conjunction with other more appropriate insulating materials or if located and protected against mechanical damage and the absorption of moisture is minimized. When it is necessary to investigate a material to determine whether it is acceptable, consideration is to be given to its mechanical strength, dielectric properties, 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 actual service. All these factors are considered with respect to thermal aging. The appropriate tests in the Standard for Polymeric Materials – Use in Electrical Evaluations, UL 746C, see Electrical Insulation Section, are to be used to evaluate a material for the above-mentioned properties.

Exception: Thermoset materials are not required to comply with the relative thermal capability requirements in UL 746C. For a thermoset material operating at a temperature above its temperature rating, the 1000 hour Aging Test as specified in 43.1 shall be conducted.

14.3 In the mounting or supporting of small, fragile insulating parts, screws or other fastenings should not be tight enough to cause cracking or breaking of these parts with expansion and contraction. Generally, such parts should be slightly loose.

14.4 Sleeving or tubing used as an insulator for uninsulated live parts (such as glass fiber in rope heaters) shall be disposed or protected so that no damage to the sleeving or tubing can result from contact with any rough, sharp, or moving part. The sleeving or tubing shall not be installed under a compression that renders it incapable of complying with the dielectric voltage-withstand requirements in 33.1.

14.5 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 14.4, 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; and

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

14.6 A printed-wiring board shall comply with the requirements in the Standard for Printed-Wiring Boards, UL 796. A printed-wiring board shall be rated V-1 or better.

14.7 Film-coated wire (magnet wire)

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

14.7.2 Film coated wire in intimate combination with one or more insulators, and incorporated in 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.

15 Thermal Insulation

15.1 Thermal insulation, if employed, shall be of such a nature and so located and mounted or supported that it is not adversely affected by any intended operation of the appliance.

15.2 Combustible or electrically conductive thermal insulation shall not contact uninsulated live parts of an appliance.

15.3 Some types of mineral-wool thermal insulation contain conductive impurities in the form of slag, which make its use unacceptable if in contact with uninsulated live parts. See 32.1.1

16 Thermal Cutoffs

16.1 If an appliance is provided with a thermal cutoff, it shall be secured in place and shall be located so that it is accessible for replacement without damaging other connections or internal wiring. See 54.6.

16.2 If an appliance is provided with a thermal cutoff, it shall be capable of opening the circuit in the intended manner without causing the short-circuiting of live parts and without causing live parts to become grounded to the enclosure when the appliance is connected to a circuit of voltage in accordance with 31.1.9, and operated in a normal position to cause abnormal heating.

16.3 To determine whether a thermal cutoff complies with the requirement in 16.2, the appliance is to be operated with separate links five times as described above while any other thermally operated control devices in the appliance are short-circuited. Each link is required to perform acceptably. During the test, the enclosure is to be connected through a 3-A fuse to a supply conductor not containing the thermal cutoff.

17 Lampholders

17.1 A lampholder supplied as a part of an appliance equipped with a polarized or grounding type attachment plug shall be wired so that the screw shell is connected to the grounded conductor.

17.2 Except as noted in 17.3, a lampholder shall be designed and installed so that uninsulated live parts other than the screw shell are not exposed to contact by persons removing or replacing lamps in normal service.

17.3 The requirement in 17.2 does not apply if, in order to remove or replace a lamp, it is necessary to dismantle the appliance by means of tools.

17.4 Lampholders and indicating lamps with integral lamp/lampholder (e.g. neon pilot lamp) shall comply with the Standard for Lampholders, UL 496.

18 Switches

18.1 A switch or other control device provided as a part of an appliance shall have a current and voltage rating not less than that of the circuit (load) which it controls.

18.2 A switch employed on an appliance shall be located or protected so that it is not subjected to mechanical damage in normal use.

18.3 A switch on a waffle-maker-type appliance with removable grids shall be of such a type and so connected that it disconnects any open-wire element or elements that it controls from all conductors of the supply circuit.

18.4 The requirement in 18.3 applies to a switch in the "off" position or any other setting in which the element is not heated, and also to a through-cord switch or a plug in which a switch is incorporated in a detachable or non-detachable power-supply cord that is provided with such a heating appliance.

18.5 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 intended to be grounded. Table 10.2 specifies the identification of the power supply cord conductor intended to be grounded.

18.6 A switch shall not be incorporated in a wooden handle or in other combustible material unless enclosed in metal or an acceptable insulating material.

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

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

b) Deleted.

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

d) The Standard for Non-industrial 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.

18.8 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.

18.9 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 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 Solid-State Controls for Appliances, UL 244A.

19 Dual Voltage Appliances

19.1 The construction of the circuit voltage selector shall be such that the circuit voltage setting cannot be changed inadvertently.

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

19.3 An appliance that can be set to different rated supply circuit voltages shall be provided with the statement required by 58.6.

20 Controls and Control Circuits

20.1 General

20.1.1 The operation of an auxiliary control device in a waffle-maker-type appliance with removable grids shall disconnect the element or elements which it controls from all ungrounded conductors of the supply circuit.

20.1.2 A safety or temperature-limiting control designed to prevent risk of fire or electric shock shall be operative whenever the appliance is connected to its power supply.

20.1.3 A control device shall not be designed to deliberately overload the branch-circuit protective device as a means of disconnecting the appliance from the supply.

20.2 Terminals of safety devices

20.2.1 The terminals of a safety device within the enclosure of a heating appliance shall be so located or further enclosed that they are protected against unintentional short-circuiting and damage.

20.3 Controls

20.3.1 Auxiliary controls shall be evaluated in accordance with the applicable requirements of this end product Standard and the parameters in Controls – End Product Test Parameters, Section 20B, unless otherwise specified in this end product Standard; see 20.3.7.

20.3.2 Operating (regulating) controls shall be evaluated in accordance with the applicable component standard requirements specified in Electromechanical and Electronic Controls, Section 20A, if applicable, and the parameters in Controls – End Product Test Parameters, Section 20B, unless otherwise specified in this end product Standard; see 20.3.7.

20.3.3 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.

20.3.4 Protective (limiting) controls shall be evaluated in accordance with the applicable component standard requirements specified in Electromechanical and Electronic Controls, Section 20A, and if applicable, the parameters in Controls – End Product Test Parameters, Section 20B, unless otherwise specified in this end product Standard.

20.3.5 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 in Annex H.

20.3.6 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.

20.3.7 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, need only be subjected to the applicable requirements of this end product Standard.

20A Electromechanical and Electronic Controls

20A.1 A temperature control shall comply with one of the following:

a) The Standard for Solid-State Controls for Appliances, UL 244A;

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

20A.2 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 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 Temperature Sensing Controls, UL 60730-2-9, with Annex J; or

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

20A.3 A thermal cutoff shall comply with the Standard for Thermal-Links – Requirements and Application Guide, UL 60691.

20B Controls – End Product Test Parameters

20B.1 General

20B.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 21.

20B.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.

20B.2 Auxiliary controls

20B.2.1 Auxiliary controls shall not introduce a risk of electric shock, fire, or personal injury.

20B.2.2 Auxiliary controls shall comply with the requirements of this end product Standard.

Exception: An auxiliary control that complies with a component standard specified in Electromechanical and Electronic Controls, Section 20A, is considered to fulfill this requirement.

20B.3 Operating controls (regulating controls)

20B.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 20B.1;

e) For the applicable Material Group, see Table 20B.2; and

f) For the applicable Pollution Degree, see Table 20B.3.

Table 20B.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 20B.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)	III[a]
100 ≤ CTI < 175 (PLC = 4)	IIII[b]
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 20B.3
Pollution degrees

Appliance control microenvironment	Pollution degree
No pollution or only dry, nonconductive pollution. The pollution has no influence. Typically a 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

20B.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, 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 20B.1;

d) For the applicable Material Group, see Table 20B.2; and

e) For the applicable Pollution Degree, see Table 20B.3.

20B.4 Protective controls (limiting controls)

20B.4.1 An electronic control that performs a protective function shall comply with the applicable requirements in Controls and Control Circuits, Section 20, while tested using the parameters in this section. Examples of protective controls are as follows:

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.

20B.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; see Normal Temperature Tests, Section 31;

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; see Normal Temperature Tests, Section 31. 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; see Normal Temperature Test, Section 31; and

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

20B.4.3 The test parameters and conditions used in the investigation of the circuit covered by 20B.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 appliances covered by this end product 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 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;

j) Conduct a failure-mode and effect analysis (FMEA); and

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.

20B.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.

20B.5 Controls using a temperature sensing device

20B.5.1 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 be tested using the following number of cycles when testing a sensing device in accordance with the endurance test:

a) For a device employed as a operating device – 6,000 cycles;

b) For a device employed as a protective device – 100,000 cycles; and

c) For a device employed as a combination operating and protective device – 100,000 cycles.

21 Spacings

21.1 General

21.1.1 The spacings through air and over surface in an appliance shall not be less than 1/16 inch (1.6 mm) between uninsulated live parts of opposite polarity; and between a rigidly mounted uninsulated live part and a dead metal part that either is exposed for persons to contact or may be grounded.

Exception No. 1: If exact centering of the cold pin of a sheathed-type heating element is required to maintain the 1/16 inch (1.6 mm) spacing, a spacing of 3/64 inch (1.2 mm) in one location is acceptable.

Exception No. 2: Spacings in an appliance that comply with 21.1.2 need not comply with 21.1.1.

21.1.2 At closed-in points only, such as the screw-and-washer construction of an insulated terminal mounted in metal, a spacing of 3/64 inch (1.2 mm) is acceptable. Within a thermostat, except at contacts, the spacings between uninsulated live parts on opposite sides of the contacts shall not be less than 1/32 inch (0.8 mm) through air and 3/64 inch (1.2 mm) over the surface of insulating material, and the construction shall be such that the spacings are maintained permanently.

21.2 Barriers

21.2.1 An insulating liner or barrier of fiber or similar material employed where spacings would otherwise be unacceptable, shall not be less than 0.032 inch (0.8 mm) thick and shall be so located or of such material that it cannot be adversely affected by arcing, except that fiber not less than 0.016 inch (0.4 mm) thick may be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

Exception: Insulating material having a thickness less than specified may be used if it is acceptable for the application.

21.2.2 Unless protected from mechanical abuse during assembly and normal functioning of an appliance, a barrier of mica shall be 0.010 inch (0.25 mm) or thicker.

21A Spacings On Printed-Wiring Boards

21A.1 As an alternative to the spacing requirements of 21.1.1, 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 Dielectric Voltage-Withstand Test, Section 33;

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;

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 the 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.

21A.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 electric cooking appliance is to be categorized as Overvoltage Category II, see Table 20B.1;

b) The applicable Material Group, see Table 20B.2;

c) The Pollution Degree shall be Pollution Degree 2, see Table 20B.3; and

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.

21A.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.

22 Overheating Protection

22.1 The requirements in 22.2 – 22.5 apply to cooker/fryers, deep fryers, and oil fondue appliances that do not employ probe-type temperature controls or an appliance provided with an enclosure complying with 7.5. These requirements are in addition to or modify the applicable requirements in Section 16, Thermal Cutoffs; Section 21, Spacings; and Section 46, Abnormal Operation Test.

22.2 An appliance shall be provided with a separate and distinct temperature-limiting device to limit temperatures within the appliance. A single combination regulating-limiting control is unacceptable for this purpose.

Exception: A temperature-limiting device is not required if, with all thermally responsive devices short-circuited, the results of all appropriate abnormal tests in Abnormal Operation Test, Section 46, are acceptable.

22.3 A limiting device shall be any one-time device or manual-reset thermostat, inaccessible to the user, (see 7.11 – 7.14) that performs its intended function when tested according to these requirements.

22.4 A single-operation thermostat or a manual-reset thermostat that is provided as the temperature-limiting device shall comply with the applicable requirements for single-operation devices in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873. 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.

Exception: A thermoset that complies with 22.6 need not comply with 22.4.

22.5 A thermal cutoff that is provided as a temperature-limiting device shall comply with the applicable requirements in the Standard for Thermal-Links – Requirements and Application Guide, UL 60691.

Exception: A thermal cutoff that complies with 22.6 need not comply with 22.5.

22.6 A thermostat or thermal cutoff need not comply with a specific requirement in the standard indicated in 22.4 and 22.5, respectively, if the requirement:

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

b) Is superseded by a requirement in this Standard.

23 Grounding

23.1 On an appliance where grounding is required or provided, the flexible cord shall include a grounding conductor that shall be:

a) Green with or without one or more yellow stripes;

b) Connected to the grounding blade of an attachment plug of a grounding type; and

c) Connected to the enclosure of the appliance by means of a screw not likely to be removed during ordinary servicing, or by other equivalent means. Solder alone is not acceptable for making this connection.

23.2 All exposed dead metal parts of a cord-connected appliance that is equipped with a grounding-conductor, and all dead metal parts within the enclosure that are exposed to contact during any user serving and are likely to become energized, shall be conductively connected to the grounding conductor of the power-supply cord.

23.3 A separable connecting device provided with a grounding connection shall be such that the appliance grounding connection is made before connection to, and broken after disconnection from, the supply circuit.

Exception: This requirement does not apply to an interlocking plug, receptacle, and connector that is not energized when the appliance grounding connection is made.

23.4 The resistance shall not be more than 0.1 ohm between any point required to be grounded, as mentioned in 23.2, and:

a) The equipment-grounding conductor terminal in the case of an appliance intended for permanent electrical connection; or

b) The point to which the grounding conductor of the power-supply cord is connected.

23.5 With reference to 23.4, the resistance shall be determined by any convenient method. However, if a resistance of greater than 0.1 ohm is indicated, then either a direct or alternating current is to be passed between the points in question, the resultant voltage drop (in ohms) computed by dividing the voltage drop (in V) by the current (in A). The value of the current is to be 30 Amps, which is equal to the current rating of the largest overcurrent protective device anticipated in a branch circuit to which the appliance can be properly connected.

24 Protection Against Personal Injury

24.1 Materials employed in the construction of the appliance depended upon to reduce the risk of personal injury shall be appropriate for the particular use. See 7.1 and 7.4.

24.2 An enclosure, a frame, a guard, a handle, or the like shall not be sufficiently sharp to constitute a risk of injury to persons during normal maintenance and use.

Exception No. 1: A part or portion of a part needed to perform a working function need not comply with this requirement.

Exception No. 2: A part or portion of a part inaccessible to the probe illustrated in Figure 7.2 need not comply with this requirement.

24.3 Compliance with the requirement of 24.2 is determined by applying the test procedures, equipment, and acceptance criteria described in the Standard for Tests for Sharpness of Edges on Equipment, UL 1439.

24.4 The stability of an appliance shall be such that it will not be readily overturned in normal use.

24.4.1 With any separable basket removed, the construction of a deep fryer or cooker/fryer appliance shall not have a maximum length or width exceeding 23 inches (58.4 cm), including any parts under normal use such as feet, handles, detachable supply cord, and associated parts.

24.5 The release mechanism for detachable handles shall be:

a) Located and/or guarded such that inadvertent detachment of the handle does not occur during intended use of the appliance; and

b) Constructed so that complete and proper engagement of the handle is obvious to the user during the operation of attaching the handle.

24.6 Deep fryer food basket handles shall be provided with integral parts that interlock so that the handle does not accidentally detach or collapse from the basket during use.

24.6.1 A food basket or other suitable mechanism shall be provided with a deep fryer or cooker/fryer intended for large items. The mechanism shall be provided with a handle(s) that prevents the basket from freely swinging/twisting during loading and unloading of the fryer.

24.6.2 A deep fryer or cooker/fryer intended for large items shall be provided with a lid or cover for normal use.

24.7 If proper positioning of any deep fryer basket/handle part is essential to prevent accidental detachment or collapse of the basket handle, the part shall be permanently marked to indicate its function, namely “lock”. The direction of locking shall also be indicated. See 56.3.

24.8 Operation of a deep fryer or cooker/fryer shall not necessitate that the highest point of the gripping surface of the basket or other mechanism used to manipulate or remove the food load to exceed a vertical height of 24 inches (61 cm) from the countertop surface. Other portions of the appliance and any associated parts, such as the top edge of the basket, may exceed a vertical height of 24 inches (61 cm).

24.9 Food intended to be cooked by a deep fryer or cooker/fryer based on manufacturer's instruction manual in combination with any basket or accessory shall not be in excess of 15 lb (6.8 kg) per 24.8.

24.10 The battery compartment of an appliance or any accessory, such as a wireless control, incorporating one or more replaceable coin cell batteries of lithium technologies shall comply with the Standard for Products Incorporating Button or Coin Cell Batteries of Lithium Technologies, UL 4200A, if the appliance or any accessory is intended for use with one or more single cell batteries having a diameter of 1.25 in (32 mm) maximum with a diameter greater than its height.

24A Ground-Fault, Arc-Fault, and Leakage Current Detectors/Interrupters

24A.1 Ground-fault circuit-interrupters (GFCI) shall comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943. The following statement, or equivalent, shall be included as a marking near the GFCI, or as an instruction in the manual: "Press the TEST button (then RESET button) every month to assure proper operation."

24A.2 Appliance-leakage-current interrupters (ALCI) shall comply with the Standard for Appliance-Leakage-Current Interrupters, UL 943B. An ALCI is not considered an acceptable substitute for a GFCI when a GFCI is required by the National Electrical Code, NFPA 70.

24A.3 Equipment ground-fault protective devices shall comply with the Standard for Ground-Fault Sensing and Relaying Equipment, UL 1053, and applicable requirements of the Standard for Ground-Fault Circuit-Interrupters, UL 943.

24A.4 Arc-fault circuit-interrupters (AFCI) shall comply with the Standard for Arc-Fault Circuit-Interrupters, UL 1699.

24A.5 Leakage-current detector-interrupters (LCDI) and any shielded cord between the LCDI and appliance shall comply with Standard for Arc-Fault Circuit-Interrupters, UL 1699.

24A.6 An arc-fault circuit-interrupter (AFCI) or leakage-current detector-interrupter (LCDI), when used on equipment having a power supply cord and plug, shall be installed as an integral part of the attachment plug or located in the supply cord within 4 inches (102 mm) of the attachment plug.

24A.7 Arc fault detection testing shall include the applicable UL 1699 tests required for cord-type arc-fault circuit-interrupters.

Exception: The carbonized path arc clearing time test is not applicable for LCDIs that are provided with shielded power-supply cords.

24B Surge Protective Device

24B.1 When required by this end-product Standard, or when provided as part of an end product, a device providing surge protection or transient suppression shall comply with the Standard for Surge Protective Devices, UL 1449.

PERFORMANCE

25 General

25.1 The performance of an appliance shall be investigated by subjecting the requisite number of samples to all the applicable tests as described in Sections 26 – 50. Insofar as practicable, the tests shall be conducted in the order in which they are presented here. Samples employed for leakage-current tests shall be first tested for leakage prior to employing the samples for other tests.

26 Power Input Test

26.1 The power input to an appliance shall not be more than 105 percent of its marked rating.

26.2 To determine whether an appliance complies with the requirement in 26.1, the power input is to be measured with the appliance at normal operating temperature under full-load conditions and while connected to a supply circuit adjusted to be the marked voltage rating. If an appliance employs a nonmetallic element (such as carbon), the power input is to be determined for a new element.

27 Leakage Current Test

27.1 The leakage current of a cord-connected appliance rated for a nominal 120-V or 240-V supply when tested in accordance with 27.3 – 27.7 shall not be more than:

a) 0.5 mA for an ungrounded (2-wire) appliance;

b) 0.5 mA for a grounded (3-wire) appliance that is easily carried or conveyed by hand; and

c) 0.75 mA for a grounded (3-wire) permanently connected appliance, or a cord connected appliance that is intended to be fastened in place or located in a dedicated space and employing a standard attachment plug rated 20 A or less.

Exception: The leakage current of an appliance incorporating a sheath type heating element, when measured in accordance with 27.3 – 27.7, shall not exceed 2.5 mA during the first 5 minutes after reaching the leakage current limit of 0.5 mA or 0.75 mA, as applicable, and at the end of this time, the leakage current shall be not more than the 0.5 mA or 0.75 mA limit as applicable– the leakage current is to be monitored during heat-up and cool-down.

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

27.3 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible and from one surface to another where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure considered acceptable for

protection against electric shock as defined in 7.1 – 7.14. 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 which do not present a risk of electric shock.

27.4 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 with an area of 10 by 20 cm in contact with the surface. Where the surface is less than 10 by 20 cm, the metal foil is to be the same size as the surface. The metal foil is not to remain in place along enough to affect the temperature of the appliance.

27.5 The measurement circuit for leakage current is to be as shown in Figure 27.1. The ideal measurement instruction is defined in items A – D. The meter which is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the ideal instruments. The meter used need not have all the attributes of the idea instrument.

a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 µF.

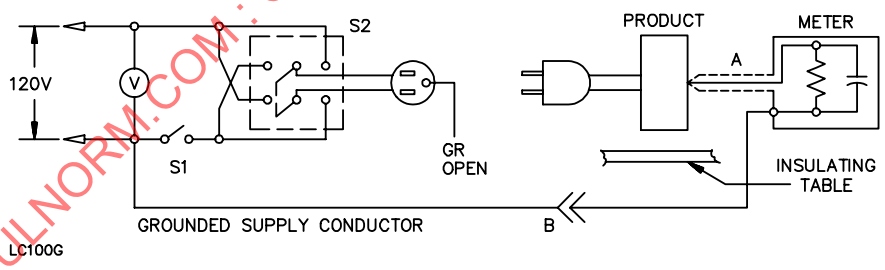
b) The meter is to indicate 1.11 times the average of the full-wave rectified composition waveform of voltage across the resistor or current through the resistor.

c) Over a frequency range of 0 – 100 kHz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) that is equal to the ratio of impedance of a 1500 ohm resistor shunted by 0.15 µF capacitor to 1500 ohms. At an indication of 0.5 mA, the measurement is to have an error of not more than 5 percent at 60 Hz.

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

Figure 27.1

Leakage-current measurement circuit



NOTE:

A: Probe with shielded lead.

B: Separated and used as clip when measuring currents from one part of device to another

27.6 A sample of the appliance is to be tested for leakage current starting with the "as received" condition with all its switches and thermostats closed, but its grounding conductor, if any, open at the attachment plug. The “as received” condition being without prior energization, except as may occur as part of the production line testing. The supply voltage is to be 120 to 240V. The test sequence, with reference to the measuring circuit (Figure 27.1), is to be as follows:

a) With switch S1 open, the appliance is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2.

b) Switch S1 is then to be closed, energizing the appliance, and within a period of 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 condition. 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 thermostat does not cycle at the maximum heat setting, it is to be adjusted until it 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, monitoring of leakage current is to continue until the leakage current stabilizes or decreases after the appliance is turned off.

27.7 Normally a sample will be carried through the complete leakage current test program as covered by 27.6 without interruption for other tests. With the concurrence of those concerned, the leakage current tests may be interrupted for the purpose of conducting other non-destructive tests.

28 Operational Tests

28.1 Operation of an appliance while simulating anticipated conditions of use shall not increase the risk of fire, electric shock, or injury to persons.

28.2 In conducting the test, the conditions mentioned in the manufacturer's instructions, including cleaning, maintenance, and the use of accessories may be included or omitted to simulate reasonably foreseeable actions of the user.

28.3 Compliance with 24.9 is determined by measurement with a maximum representative food load prepared per the manufacturer's instructions in combination with any basket or accessory intended to be lifted by the user during the cooking process.

29 Calibration Tests of Probe-Type Temperature Controls

29.1 The maximum temperature at the center of the underside of the appliance cooking surface shall not be higher than 300°C (572°F) either before or after a probe-type control is dropped in accordance with 29.2. The average of the maximum and minimum temperatures shall not be higher than 260°C (500°F) either before or after the dropping.

29.2 Six samples of each control are to be calibrated, and the maximum or minimum temperature in any case is to be the average of at least five temperature readings taken during the cycling of the control after a stabilized cycling pattern has been established. After the initial calibration, each control, while still heated, is to be dropped five times from a height of 3 ft (0.91 m) onto a hardwood surface, following which the control is to be recalibrated.

29.3 The normal temperature test is to be conducted:

a) Employing the sample probe-type control that results in the highest center temperature before the drop test, and also, employing the sample probe-type control that results in the highest center temperature after the drop test, if that temperature is higher than the highest temperature obtained before the drop test; or

b) Employing the sample probe-type control that results in the highest center temperature after the drop test, if that temperature is higher than the highest temperature obtained before the drop test. However, if the highest center temperature is obtained before the drop test, a sample probe-type control that is calibrated to provide the highest center temperature is to be employed.

30 Mechanical Abuse

30.1 A detachable power-supply cord employing a magnetic appliance coupler that complies with the requirements of the Standard for Attachment Plugs and Receptacles, UL 498 or the Standard for Cord Sets and Power-Supply Cords, UL 817 need not comply with 30.2 and 30.3. A detachable power-supply cord set employing a magnetic appliance coupler and manufactured specifically for use with a deep fryer, cooker/fryer, or oil fondue appliance need not comply with the Mechanical Endurance Test in UL 498 or UL 817 (though it must comply with all other applicable requirements in UL 498 or UL 817) provided that it complies with 30.2 and 30.3.

30.2 Each of six representative detachable power-supply cords employing a magnetic appliance coupler used in deep fryers, cooker/fryers, and oil fondue appliances is to be placed in a full-draft circulating-air oven for 24 hours at 10°C (18°F) higher than the maximum temperature on the magnetic appliance coupler, as measured under normal operating conditions, but not less than 70°C (158°F). After the conditioning and allowing to cool to room temperature, each magnetic appliance coupler is to be examined for cracking, shrinkage or warping to the extent that the magnetic appliance coupler remains fully functional.

30.3 Each of the representative power-supply cords is to be bundled with the coupler under the cord and then allowed to drop as an assembly freely from a height of 3 feet (0.91 m) onto a hardwood surface (consisting of a layer of nominally 1-inch thick tongue-and-groove oak flooring mounted on two layers of 3/4-inch plywood) for a total of 125 drops, such that the coupler is impacted at various locations. Upon completion of the first 50 drops, each representative power-supply cord shall:

a) Be fully functional; and

b) Not crack or break to the extent that it becomes unfit for use or exposes live parts to unintentional contact; and

c) Not experience any displacement of current-carrying parts or loosening of the cord at the wiring terminals.

Following the above, each of the representative power-supply cords is to be dropped an additional 75 times. Upon completion of the 125 drops, the representative power-supply cords shall be in compliance with (b) and (c).

31 Normal Temperature Test

31.1 General

31.1.1 An appliance, when tested under the conditions described in 31.1.4 – 31.2.5.3, shall comply with all three of the following conditions:

a) The appliance shall not attain at any point a temperature that constitutes a risk of fire or damages any materials employed in the appliance.

b) At any time during the test – other than as indicated in 31.1.2 and 31.1.3 – temperature rises at specific points shall not be greater than indicated in Table 31.1.

c) The appliance shall comply with the requirement in 7.1.

Table 31.1
Maximum acceptable temperature rises

	Material and component parts	°C	(°F)
1.	Fiber used as electrical insulation or as cord bushings	65	(117)
2.	Wood or other combustible material which is a part of a heating appliance	65	(117)
3.	Cotton or rayon braid of a flexible cord	65	(117)
4.	Phenolic composition used as electrical insulation or where deterioration would result in a risk of fire, electrical shock or personal injury[a]	125	(225)
5.	Points on surface supporting an appliance and on adjacent surfaces of test corner	100	(180)
6.	Points on adjacent surface of test corner	100	(180)
7.	Flatiron or appliance plug	175	(315)
8.	Insulated wire or cord	25°C (77°F) less than its temperature rating[b]	
9.	Sealing compound	c	c
10.	A. Copper, tinned or bare strands:		
	a) less than 0.015 inch (.38 mm) in diameter	125	(225)
	b) 0.015 inch diameter and larger	175	(315)
	B. Nickel, gold or silver platings or combinations of those platings, over copper conductors	225	(405)
11.	Termination of copper conductor and pressure terminal connector without being nickel-coated or otherwise acceptably protected.	125	(225)

[a] The limitation on phenolic composition does not apply to a compound which has been investigated and found to have special heat-resistant properties.

[b] Inside an appliance, the temperature rise on a wire or cord may be greater than the specified maximum rise, provided that the insulation on each individual conductor is protected by supplementary insulation (such as braid, wrap, tape or close-fitting tubing) which is entirely acceptable for the temperature and the type of insulation involved.

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

31.1.2 Initial temperature transients may be in excess of the temperature limits specified in Table 31.1 and 31.1.3 if the duration and extent of the excursion do not result in risk of fire or electric shock and do not unduly shorten the life of the appliance.

31.1.3 Temperatures are to be measured during preheat modes. Temperature rises not exceeding those specified in Table 31.1 by more than 20 percent are acceptable.

31.1.4 All values in Table 31.1 are based on an assumed ambient (room) temperature of 25°C (77°F), but a test may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F). However, if the operation of an automatic thermal control during the test limits the temperatures under observation, no temperature higher than 25°C (77°F) plus the specified maximum rise is acceptable.

31.1.5 In an appliance that can hold an appreciable quantity of oil, fat, or grease during the cooking operation, the maximum and average temperatures measured at the center of the cooking surface shall not be higher than 300°C (572°F), and 260°C (500°F), respectively. These temperatures are to be measured after a stabilized cycling pattern has been established. The temperature at any point on the cooking surface shall not exceed 390°C (734°F) at any time during the test.

Exception: Corn popping appliances shall comply with 31.2.5.1 – 31.2.5.3.

31.1.6 Temperatures are to be measured by thermocouples consisting of wires no larger than 24 AWG (0.21 mm^2) and no smaller than 30 AWG (0.05 mm^2), except that a coil temperature may be determined by

the change-of-resistance method if the coil is inaccessible for mounting thermocouples. When thermocouples are used in determining temperatures in electrical equipment, thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer-type instrument, are to be used whenever referee temperature measurements by thermocouples are necessary.

31.1.7 For tests that are to be continued until constant temperatures are attained, thermal equilibrium is to be considered to exist only if three successive readings indicate no change when taken at the conclusion of each of three consecutive equal intervals of time, the duration of each interval being whichever of the following is longer:

a) 5 minutes; or

b) 10 percent of the total test time elapsed previous to the start of the first interval.

The thermocouple wire is to conform with the requirements specified in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M. The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice.

31.1.8 A thermocouple junction and adjacent thermocouple lead wire are to be securely held in good thermal contact with the surface of the material whose temperature is being measured. In most cases, good thermal contact with result from securely taping or cementing the thermocouple in place but, if a metal surface is involved, brazing or soldering the thermocouple to the metal may be necessary.

31.1.9 To determine whether an appliance complies with the requirements in 31.1.1, the appliance is to be operated continuously until constant temperatures have been reached. The test voltage is to be the marked voltage rating or the test voltage specified is to be increased, if necessary, to cause the wattage input to the appliance to be equal to the wattage rating marked on the appliance.

31.1.10 In conducting a test to determine whether an appliance complies with the temperature requirements, it is to be mounted or supported as in service and tested under conditions approximating those of normal operation, except as otherwise noted. Temperatures are to be observed on nearby surfaces, on the supporting surface, at points of support, on attachment plugs, and at other points as may be necessary.

31.1.11 Unless otherwise indicated in the description of the test for a specific appliance, a cord-connected appliance is to be supported on two layers of white tissue paper on a softwood surface.

31.1.12 An appliance is to be tested in a test corner with the appliance located 4 inches (100 mm) away from the side and rear walls of the test corner. The 4 inch (100 mm) spacing is to be measured from the outer most extremity of the appliance. The test corner is to consist of dull black-painted fir plywood not less than 3/8 inch (9.5 mm) thick, having such width and height that the walls extend not less than 2 ft (0.61 m) beyond the physical limits of the appliance. The vertical walls are to meet at a right angle.

31.1.13 Thermocouples are to be mounted on wood surfaces using the method illustrated in Figure 31.1 or the equivalent. Starting in the corner, thermocouples are to be placed every 3 inches (76 mm) on each surface (Figure 31.2) so that a minimum area of 18 inches by 18 inches (460 mm by 460 mm) is covered by the thermocouples on each surface.

Figure 31.1

Method of mounting thermocouple

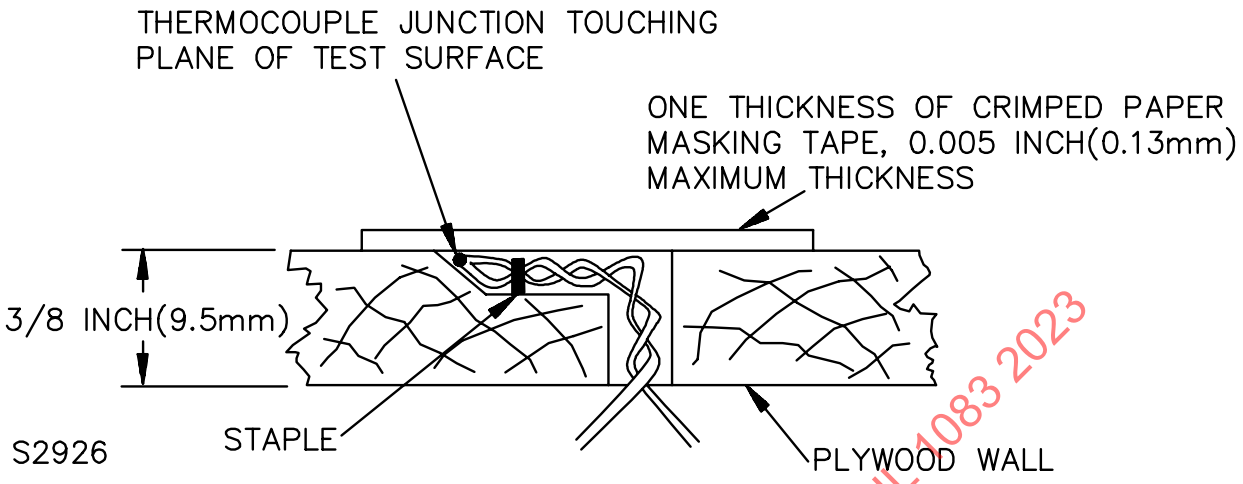
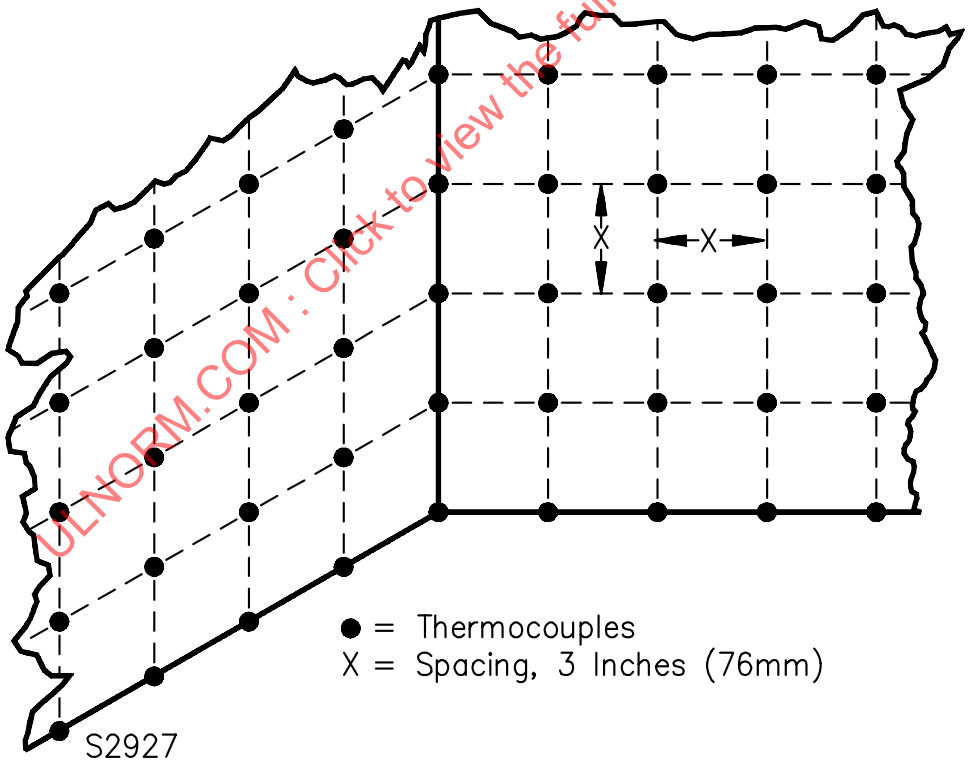


Figure 31.2

Thermocouple spacings



31.1.14 An automatic temperature-regulating or -limiting control or other protective device provided as a part of an appliance is to be shunted out of the circuit, unless the control has been shown in accordance with Table 48.1 to be rugged, reliable, and unlikely to be defeated by the user. The control is considered to be unlikely to be defeated if tools are required to gain access to the control, or a positive stop is incorporated in the control.

31.1.15 During the normal temperature test, a temperature-limiting device provided for overheating protection shall not operate.

31.1.16 If the design of a heating appliance is such that cooking or heating of a liquid is a determining factor in the temperature attained, the intended duty of the appliance is to be taken into consideration. In determining whether an appliance complies with the requirements in 31.1.1, actual service conditions or an approximation thereof are to be employed unless otherwise specifically indicated below:

a) If the appliance is controlled by an adjustable thermostat, the thermostat is to be set to give maximum temperatures; and

b) If the appliance is controlled by a nonadjustable thermostat, it is to be allowed to operate at whatever temperature the thermostat permits. In each case, operation is to be continued until temperatures are stabilized.

31.1.17 An appliance such as a waffle or sandwich maker which may be either open or closed in actual service, is to be tested both open and closed to determine which condition produces the higher operating temperature.

31.1.18 An appliance that is required to be preheated as part of the temperature or abnormal tests is to be preheated as follows:

a) In accordance with the manufacturer's instructions marked in a readily visible location on the appliance; or

b) If not marked, the appliance is to be operated for 15 minutes at the temperature setting specified for the cooking portion of the test.

Exception: An appliance is not to be preheated if the manufacturer's instructions specifically state that preheating of the appliance is not necessary. See 57.1.

31.1.19 Whenever hamburger is mentioned in connection with either a temperature or an abnormal test, each hamburger is to consist of a mixture of 75 percent lean beef and 25 percent suet by weight ground together twice in succession. A hamburger is to be 3/4 inch (19 mm) thick and have a 4 inch (102 mm) diameter before cooking. The initial internal hamburger temperature is to be 4.4°C (40°F). A hamburger is considered well done when a central internal temperature of 74°C (165°F) is attained on a centrally located hamburger.

31.1.20 A deep fryer or cooker/fryer shall not overflow onto the supporting surface during this test.

31.2 Specific test conditions

31.2.1 General

31.2.1.1 For most of the common types of appliances, standardized normal conditions for the temperature tests are given in 31.2.2 – 31.2.10.

31.2.2 Deep fryers and cooker/fryers

31.2.2.1 The fryer is to be filled with commercially available peanut oil to the level indicated on the appliance or in the instruction manual. The fryer is to be preheated in accordance with 31.1.18 and then 3 batches of french fries are to be cooked, according to the manufacturer's instructions. Each batch is to be cooked to a medium brown color. A medium brown color is to be determined by use of the french fries color chart in Appendix B. Unloading and loading between batches is to be accomplished in 15 – 30 seconds. Each batch of french fries is to consist of the maximum load recommended. The french fries are

to be made using fresh standard baking potatoes cut 3/8 – 1/2 inch (9.6 – 12.7 mm) on a side and are to be of any convenient length. See 31.1.5 for the cooking surface temperature test.

31.2.2.2 For Deep Fryers or Cooker/Fryers intended to be used with a large item foods, the appliance shall also be subjected to the test described in 31.2.2.3.

31.2.2.3 The fryer shall be operated as described in 31.2.2.1, except a single cooking cycle shall be conducted using the largest recommended individual large item food considering weight and surface area, with the longest recommended cooking time, with any adjustable thermostat set to its maximum temperature setting. The large item food shall be refrigerated and have a maximum internal temperature of 40°F (4.4°C) and prepared in accordance with the manufacturer's instruction manual, including any specified thawing. The time to cook the large item food shall be in accordance with the manufacturer's instructions, or until well done, whichever is longer. Poultry is considered to be well done when an internal temperature of the thigh of 82°C (180°F) is attained. All other meats are considered to be well done when a central internal temperature of 171°F (77°C) is attained.

31.2.3 Waffle bakers and sandwich grills

31.2.3.1 A waffle baker, or a combination unit, is to be preheated in accordance with 31.1.18 and then operated for 10 baking operations. Unloading and loading between operations is accomplished in 15 – 30 seconds. An adjustable temperature control is to be set at the manufacturer's recommended setting, if marked in a readily visible location, or, if not marked, at the maximum temperature setting. The waffles are to be baked to a medium brown color. A medium brown color is to be determined by the use of the waffle color chart in Appendix B. The batter is to be a commercially prepared mix.

31.2.3.2 A sandwich grill, or a combination unit, is to be preheated and then operated toasting a maximum of 10 sandwiches. An adjustable temperature control is to be set at the manufacturer's recommended setting, if marked in a readily visible location, or, if not marked, at the maximum temperature setting. For each toasting operation, the lower grill is to be filled to capacity for as many cycles as possible and the remainder of the 10 sandwiches used for the last cycle and the grill is to be closed. Unloading and loading between operations is to be accomplished in 15 – 30 seconds. Each sandwich is to consist of two slices of white bread, weighing approximately 25 g, with 2 slices of cheese [commercially available 1/2 oz (14 g) per slice processed cheese] between the bread slices. Those sides in contact with the grills are to be coated with butter. The test is to be repeated with the grills open and using only one grill to toast sandwiches. The sandwiches are to be toasted on both sides to a medium brown color. A medium brown color is to be determined by the use of the toast color chart in Appendix B.

Exception: The appliance is to be operated in the open position unless the manufacturer's instructions indicate the appliance is only to be operated in the closed position.

31.2.4 Skillets and woks

31.2.4.1 A skillet or a wok is to be operated as set forth in 31.2.4.2. However, the method indicated in 31.2.4.3 may be used as an alternate if agreeable to those concerned.

31.2.4.2 A skillet is to be preheated according to 31.1.18 and then operated baking potatoes. The potatoes are to occupy 75 – 80 percent of the cooking surface. The temperature control setting is to be adjusted to maintain a cooking temperature of 204°C (400°F) or the setting marked in a readily visible location on the product, but not less than 177°C (350°F) in any case. The potatoes are to be standard baking potatoes each weighing between 3/8 – 5/8 lb (0.83 – 1.38 kg). The test is to be terminated when the internal center temperature of a centrally located potato is 99°C (210°F).

31.2.4.3 The appliance is to be operated continuously with the thermostat set at the maximum setting until thermal equilibrium is attained. The appliance is to be filled to a depth of 1/2 inch (13 mm) with

commercially available peanut oil as measured at the center of the pan. See 31.1.5 for the cooking surface temperature test.

31.2.5 Corn poppers

31.2.5.1 Two tests shall be made. The temperature at any point on the cooking surface shall not exceed 370°C (698°F) at any time during the tests. For these tests, thermocouples shall be soldered, peened, or welded into the cooking surface.

31.2.5.2 For the first test, the appliance is to be operated dry and empty, and with the cover in place. During this test only the cooking surface temperature is to be measured.

31.2.5.3 For the second test, the manufacturer's recommended amount of oil and popping corn shall be placed in the appliance. The oil used in this test shall be pure peanut oil. The appliance shall be operated with the cover in place until the batch of ingredients is thoroughly popped. The appliance shall be immediately emptied of the corn and oil mixture and immediately refilled with fresh ingredients. The test shall be repeated through as many operations needed to attain thermal equilibrium.

31.2.6 Hamburger makers

31.2.6.1 The appliance is to be preheated according to 31.1.18 and then operated continuously cooking 10 hamburgers or 5 loads of hamburgers, whichever is more. The hamburgers are to be cooked until well done following the instruction manual directions. Grease from the hamburgers is to be drained from the appliance between cycles. 15 seconds are to be allowed for draining the grease.

31.2.7 Donut makers

31.2.7.1 The appliance is to be preheated according to 31.1.18 and then operated continuously making 20 donuts or 5 loads of donuts, whichever is more. The batter is to be prepared in accordance with the instruction manual recipe. Any thermostat is to be set at the highest setting recommended in the manufacturer's instructions. The unload/load time is to be between 15 and 30 seconds.

31.2.8 Griddles and contact grills

31.2.8.1 The appliance is to be preheated according to 31.1.18 and then operated continuously cooking 2 loads of hamburgers. Each load is to fill 75 percent of the cooking surface area and is to be cooked until well done. The thermostat is to be set in accordance with the instructions marked in a readily visible location on the product, or, if not marked, at the maximum setting. Grease from the hamburgers is to be drained from the appliance between cycles. 15 seconds are to be allowed for draining the grease.

31.2.8.2 For appliances that have more than one intended cooking position, the test of 31.2.8.1 is repeated in each position. Each time starting with the appliance at ambient temperature.

31.2.9 Crepe makers

31.2.9.1 The appliance is to be preheated in accordance with 31.1.18 and then operated continuously cooking 10 crepes, as quickly as practical. A commercially prepared mix, or a mix made following the instructions, is to be used. Any thermostat is to be set at the maximum setting.

31.2.10 Oil fondues

31.2.10.1 The oil fondue appliance is to be operated continuously, set on high, or with the thermostat set at the maximum setting, if one is provided, until thermal equilibrium is obtained. The appliance is to be

filled with commercially available peanut oil to the level indicated in the instruction manual. See 31.1.5 for the cooking surface temperature test.

31.2.11 Low temperature fondues

31.2.11.1 The low temperature fondue appliance, as described in 5.1.4, is to be operated continuously, set on high, or with the thermostat set at the maximum setting, if one is provided, until thermal equilibrium is obtained. The appliance is to be filled with liquid or sauce to the recommended level indicated in the instruction manual. The maximum temperature of the food medium measured at the center of the cooking surface shall not be higher than 110°C (230°F).

32 Insulation Resistance and Leakage Current Tests as a Result of Moisture

32.1 General

32.1.1 An appliance employing insulation material likely to be affected adversely by moisture under conditions of normal use shall be conditioned for 48 hours in moist air having a relative humidity of 88 ±2 percent at a temperature of 32 ±2°C (89.6 ±3.6°F). After the conditioning, the appliance shall comply with the requirement in 27.1 in a repeat leakage current test, except that the test shall be discontinued when leakage current stabilizes.

32.1.2 If glass-fiber sleeving is used as electrical insulation in a rope heater assembly, an additional sample of the appliance shall be tested as follows. The appliance is to be operated for 96 continuous hours under the condition resulting in the maximum temperature on the sleeving, as determined from the normal temperature test, following which it is to be conditioned for 48 hours in moist air having a relative humidity of 88 ±2 percent at a temperature of 32 ±2°C (89.6 ±3.6°F). After the conditioning, the appliance shall comply with the requirement in 27.1 in a repeat leakage current test, except that the test shall be discontinued when the leakage current stabilizes. Following the leakage current test, the appliance shall also comply with the dielectric voltage-withstand test requirement of 33.1.

32.2 Gasket & seal aging tests

32.2.1 A gasket that is depended upon to prevent the entrance of water into an appliance during cleaning shall not become hard or brittle, shall not crack, and shall show no other signs of deterioration as a result of an accelerated-aging test in which the gasket is subjected to elevated temperatures. See 32.3.4.

32.2.2 The temperature to which the gasket is subjected during the test, as well as the duration of the test, is to be determined in accordance with the material of the gasket, the temperature to which it is subjected during operation, and other conditions of the particular application. Normally the appliance is to be operated dry and for a period of 240 hours.

32.2.3 Following the accelerated aging, the sample is to be immersed, tested, and examined for the entrance of water.

32.3 Immersion

32.3.1 Except as noted in 32.3.2, an appliance that is likely to be immersed in water for cleaning shall show a leakage current of no more than 0.5 mA and shall be capable of withstanding a potential of 1000 V when tested in accordance with 32.3.2 – 32.3.5. The test shall not result in the entrance of water into the interior of the appliance such that the water might come into contact with uninsulated live parts.

32.3.2 An appliance marked to indicate that it is not intended for immersion need not comply with the requirements in 32.3.1. See 54.7.

32.3.3 Three samples of the appliance are to be heated as described in 32.3.5 and are then to be immersed immediately in water at a temperature of 10 – 25°C (50 – 77°F). The immersion is to be complete unless the appliance is marked to indicate that it is intended for partial immersion only (see 54.7), in which case each appliance is to be immersed only to the extent indicated. After 1 hour of immersion, the samples are to be removed from the water, dried with a soft cloth to remove all surface moisture, including surface moisture from terminal pins, and the samples are to be tested for leakage current.

32.3.4 The entire procedure of immersion and leakage current measurement is to be repeated four times, immediately following which each sample is to be subjected to a 1000-V dielectric voltage-withstand test as described in 33.1. The three samples are to be used for aging tests, and are required to comply with the requirements in 32.2. If there is an air cavity having electrical components, the three samples are to be disassembled and the internal parts visually examined for the presence of water (32.3.1). See Table 32.1.

32.3.5 An appliance is to be heated for the immersion test by operating it dry, with the thermostat at the highest setting, until the thermostat automatically switches to the "low" or "off" position.

Table 32.1
Immersion tests

All appliances likely to be immersed			
	Conditioning for tests		
	Sample No. 1	Sample No. 2	Sample No. 3
First 5 Cycles	Dry initially and throughout conditioning Immerse one hour Dry with cloth Leakage Current Test		
After 5th Cycle	Dielectric Voltage-Withstand Test Operate 240 hours Cool to room temperature Reheat as for Normal Temperature Test Immerse for one hour Leakage Current Test Dielectric Voltage-Withstand Test		
NOTE – If there is an air cavity housing electrical components in the appliance, disassemble and examine for water.			

32.4 Cool-down leakage current

32.4.1 When tested in accordance with the procedure specified in 27.3 – 27.6(b), as modified by 32.4.5, an immersible appliance shall not show evidence of heat-up or cool-down leakage currents greater than those specified in Table 32.2 under the test conditions in 32.4.2 – 32.4.5.

Table 32.2
Maximum acceptable leakage current in milliamperes for immersible appliances

Time period					
	S1 open	S1 closed			S1 close-control open
Conditioning		0 – 5 sec	5 sec – 10 min	At 10 min	Cool-down period
Test conducted at the end of the production line	0.5	0.5	0.5	0.5	0.5
As received	0.5	0.5	2.5	0.5	2.5
After 56 days in humidity chamber	0.5	0.5	5.0	0.5	5.0

32.4.2 A set of five samples is to be selected from the end of the production line just prior to packaging and subjected to the heat-up and cool-down leakage current test (see 32.4.5) under the humidity conditions existing at that time. The test results are to be retained with the samples for further investigation.

32.4.3 The set of five samples, as received, shall be subjected to heat-up and cool-down leakage current test to determine that the leakage current characteristics have not been affected during transit prior to insertion in the humidity cabinet.

32.4.4 The set of five samples is then to be placed in a humidity cabinet operating at 88 ±2 percent relative humidity and at a temperature of 32 ±2°C (89.6 ±3.6°F) for a period of 56 days. It is standard laboratory practice to adjust the chamber, having laboratory control accuracy, as close as possible to 90 percent relative humidity without exceeding 90 percent relative humidity. At the end of the 56 day conditioning period, the five samples are to be removed from the humidity cabinet, and subjected to the heat-up and cool-down leakage current test.

32.4.5 The heat-up and cool-down leakage current test is to be performed by energizing the immersible appliance for 10 minutes at the highest thermostat setting. The thermostat shall then be turned either to the "off" position (for a single-pole control), or the lowest temperature setting permitting single-pole operation (for a double-pole control). The values of leakage current are to be continuously observed until the temperature at the center of the appliance cooking surface is less than 90°C and the observed leakage current is decreasing.

33 Dielectric Voltage-Withstand Test

33.1 An appliance shall be capable of withstanding for 1 minute without an indication of unacceptable performance, the application of a potential applied between live parts and accessible metal parts. The appliance is to be at its maximum normal operating temperature. The test potential shall be 1000 V.

33.2 With respect to 33.1, an appliance having an enclosure constructed partly or totally of insulating material is to have accessible surfaces of the material closely wrapped in metal foil. The test potential is to be applied between live parts and the foil.

33.3 With respect to 33.1 and 33.2, a part is considered to be accessible if it can be contacted by the probe illustrated in Figure 7.2 when applied in all possible articulate positions, with and without the parts referenced in 7.14 in place.

33.4 To determine whether an appliance complies with the requirements in 33.1, the test potential is to be applied as described in 33.6, by means of test equipment having the characteristics outlined in 33.5.

33.5 The test equipment for conducting the dielectric voltage-withstand test is to have the following features and characteristics:

a) A means for indicating the test voltage that is being applied to the appliance under test. This may be accomplished by sensing the voltage at the test leads or by an equivalent means.

b) An output voltage that:

1) Has a sinusoidal waveform;

2) Has a frequency that is within the range of 40 – 70 Hz; and

3) Has a peak value of the waveform that is not less than 1.3 and not more than 1.5 times the root-mean-square value.

c) A sensitivity of the test equipment that is such that when a resistor of 120,000 ohms is connected across the output, the test equipment does not indicate unacceptable performance for any output voltage less than the specified test voltage, and the test equipment does indicate unacceptable performance for any output voltage equal to or greater than the specified test value. The resistance of the calibrating resistor is to be adjusted as close to 120,000 ohms as instrument accuracy can provide, but never more than 120,000 ohms.

Exception: The sensitivity of the test equipment may be increased, a higher value of calibrating resistance may be used, if agreeable to those concerned.

33.6 The method of applying the test voltage to the appliance is to be such that there are not any transient voltages that result in the instantaneous voltage applied to the appliance exceeding 105 percent of the peak value of the specified test voltage. The applied potential is to be increased from zero at a substantially uniform rate so as to arrive at the specified test potential in approximately 5 seconds, and then is to be maintained at the test potential for 1 minute. Manual control of the rate of rise may be used.

34 Strain Relief Test

34.1 The strain-relief means provided on an attached flexible cord, when tested in accordance with 34.2, shall be capable of withstanding for 1 minute, without displacement, a pull of 35 lbf (156 N) applied to the cord, with the connections within the appliance disconnected.

34.2 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.

35 Push-Back Relief Test

35.1 To determine compliance with 10.2.3, a product shall be tested in accordance with 35.2 without occurrence of any of the following conditions:

a) Subjecting the supply cord or lead to mechanical damage;

b) Exposing the supply cord or lead to a temperature higher than that for which it is rated;

c) Reducing spacings (such as to a metal strain-relief clamp) below the minimum required values; or

d) Damaging internal connections or components.

35.2 The supply cord or lead is to be held 1 inch (25.4 mm) from the point where the cord or lead emerges from the product and is then to be pushed back into the product. The cord or lead is to be pushed back into the product in 1 inch (25.4 mm) increments until the cord buckles or the force to push the cord into the product exceeds 6 pounds-force (26.7 N). The supply cord or lead within the product is to be manipulated to determine compliance with 10.2.3.

36 Metal Enclosure Impact Test

36.1 A metal enclosure part shall comply with the tests outlined in 36.2 – 36.5. For polymeric enclosure parts, see the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

36.2 A metal enclosure part shall withstand the ball impact, with the appliance restrained, as described in 36.3 without occurrence of any one of the following conditions:

a) Making live parts accessible to contact with the articulate probe; see 7.11 and 7.12.

b) Producing any other condition that results in damage of the enclosure so as to adversely affect the function of any safety or constructional feature; such as thermostats, overload-protective devices, or strain relief.

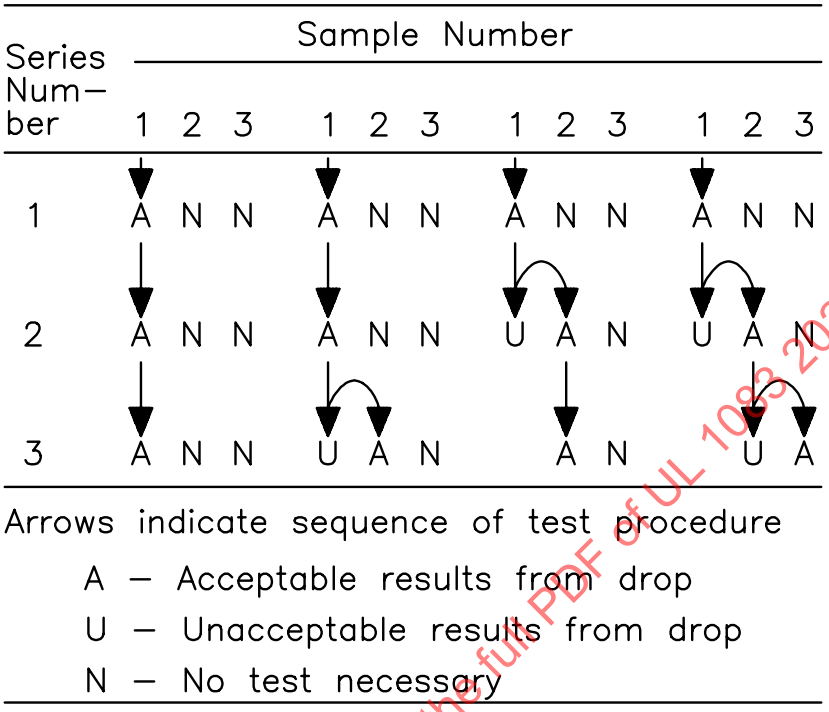
c) Producing other conditions so that the appliance does not comply with the dielectric voltage-withstand requirements in Dielectric Voltage-Withstand Test, Section 33, after being subjected to the impact.

36.3 Each of three samples of the appliance is to be subjected to one impact. This impact is to be imparted by dropping or swinging a 2-inch (50.8-mm) diameter steel sphere, weighing 1.18 lb (0.535 kg) from a height that produces an impact of 1.5 lbf (2.03 N·m). The sample is to be rigidly supported and the impact is to be made perpendicular to the most vulnerable spots on the appliance enclosure that are exposed to a blow during intended use. A different spot on the enclosure is to be selected for each impact. Refer to Figure 36.2 with respect to the ball drop impact test and to Figure 36.3 for the ball pendulum impact test.

Exception: If the manufacturer elects, fewer than three samples may be used for the test in accordance with Figure 36.1, wherein each series consists of one impact. The overall performance is acceptable upon completion of any one of the procedures represented in Figure 36.1.

Figure 36.1

Procedure for impact test



SA1162

Figure 36.2

Ball drop impact test

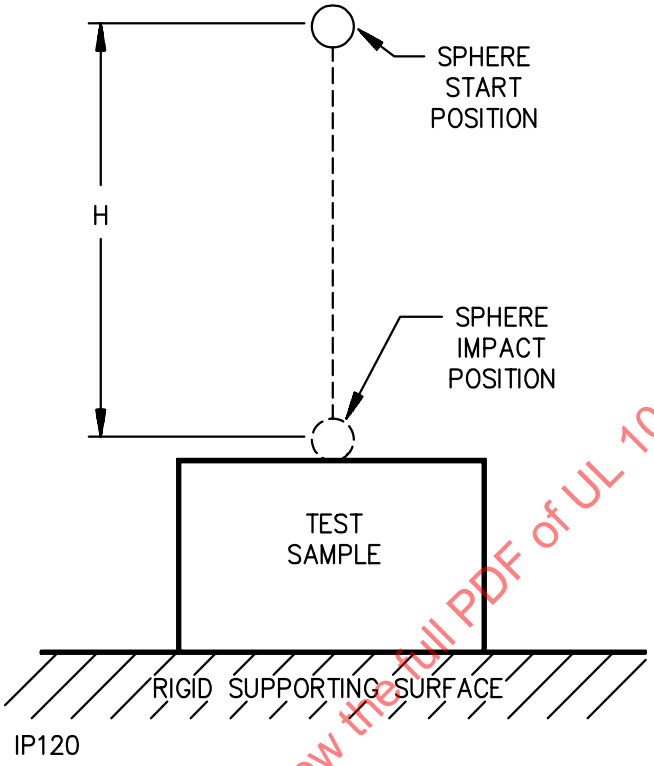
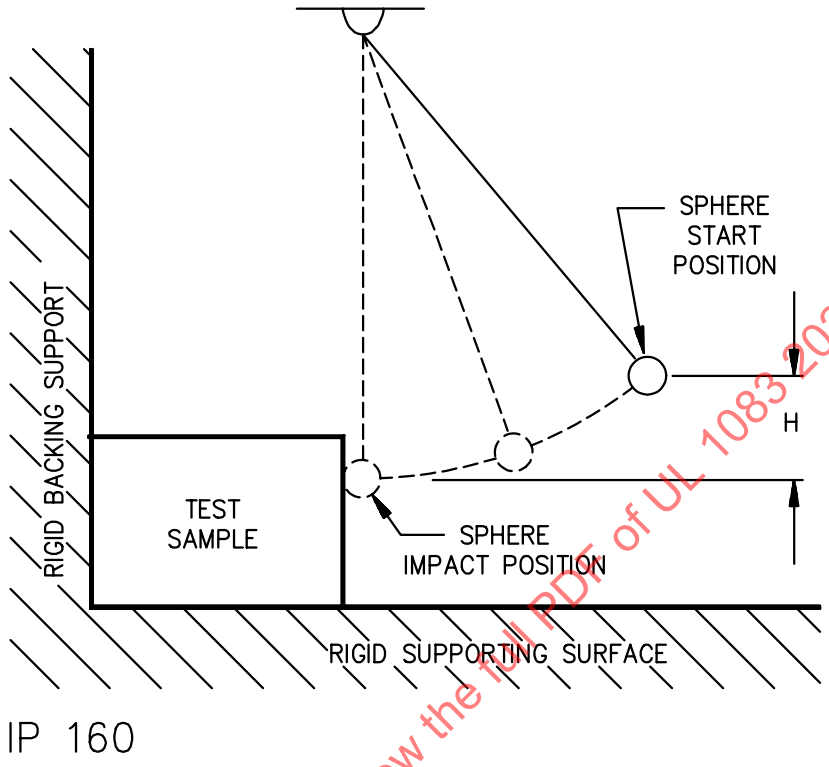


Figure 36.3

Ball pendulum impact test



36.4 With reference to Figure 36.2 and Figure 36.3, the "H" designation represents the vertical distance the sphere must travel to produce the desired impact. For the pendulum impact, the sphere is to contact the test sample when the string is in the vertical position. The supporting surface is to be as described in 36.5. The backing surface for the pendulum impact is to consist of 3/4 inch (18 mm) plywood over a rigid surface of concrete or an equivalent nonresilient backing surface may be used.

36.5 The supporting surface mentioned in 36.4 is to consist of a layer of tongue-and-groove oak flooring mounted on two layers of 3/4 inch (18 mm) thick plywood. The oak flooring is to be nominally 3/4 by 2-1/4 inch (18 by 57 mm). The assembly is to rest on a concrete floor or an equivalent nonresilient surface.

37 Stability Test

37.1 A deep fryer, cooker/fryer, or oil fondue appliance shall be placed on a plane inclined at an angle of 30 degrees to the horizontal. All other types of appliances 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, liquid, or other media (material) that results in the maximum tendency to overturn under conditions of intended use. The appliance shall be prevented from sliding on the inclined surface.

Exception: A sandwich maker, waffle maker, contact grill, or the like shall be placed on a plane inclined at an angle of 10 degrees to the horizontal with its lid open and at an angle of 15 degrees to the horizontal with its lid closed.

37.1.1 The test in 37.1 shall be repeated for a deep fryer or cooker/fryer intended for large items, except the plane shall be inclined at an angle of 15 degrees to the horizontal, and the appliance shall be loaded

with food and oil. The food load shall be representative of the largest weight and that results in the highest center of gravity of the loaded appliance. Multiple types of food loads may need to be tested to determine the food load with the maximum tendency to overturn. The food load is to be oriented and placed in the normal operating position that results in the highest center of gravity of the loaded appliance. The unit shall be tested with the loaded basket in the cooking position and in the draining position, with the lid open and closed, or any combination thereof.

37.2 As a result of this test, the appliance shall not tip-over and shall not spill any of the liquid .

38 Dynamic Stability Test – Deep Fryers, Cooker/Fryers, and Oil Fondues

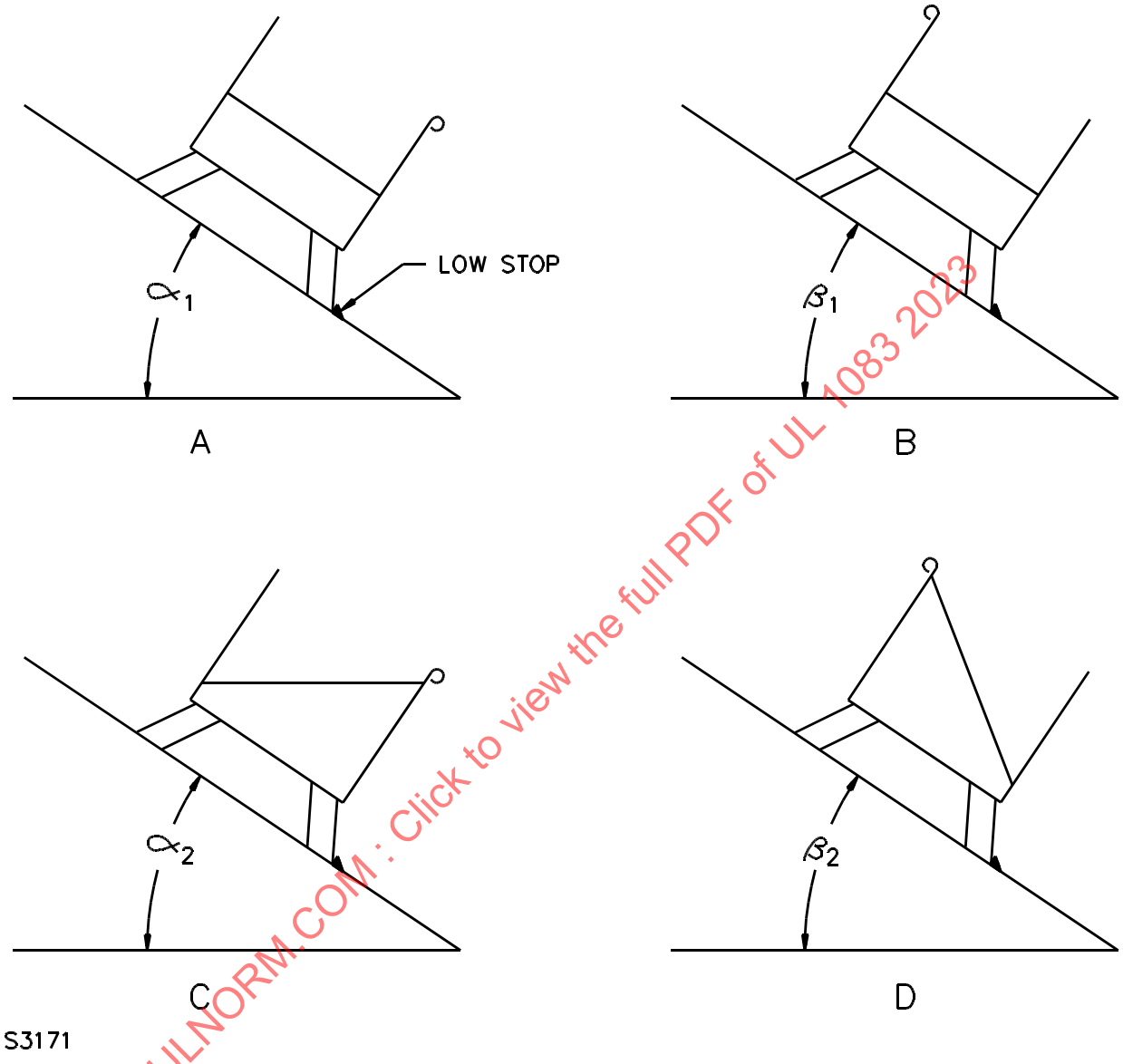
38.1 When a deep fryer, cooker/fryer, or oil fondue appliance is subject to the Dynamic Stability Test described in this Section, the minimum tip-over angle [Alpha 2 (α_2)] shall be more than 30 degrees and the calculated velocity to cause tip-over shall be more than 2 ft/s (0.61 m/s).

38.2 With the deep fryer, cooker/fryer, or oil fondue appliance, initially on a level surface, it is to be energized. While heated, it is to be filled to the recommended level with a commercially available vegetable shortening. After the shortening liquefies, the deep fryer is then to be allowed to cool until the vegetable shortening solidifies.

38.3 The deep fryer, cooker/fryer, or oil fondue appliance is then to be placed against a low stop on an adjustable inclined plane. The angle of inclination is to be increased until the deep fryer, cooker/fryer, or oil fondue appliance becomes unstable and begins to overturn. By repeating this process with the deep fryer, cooker/fryer, or oil fondue appliance rotated in various positions against the low stop, the position that is least stable is to be determined. This minimum angle to cause tipover is to be recorded as Alpha 1 (α_1). See A of Figure 38.1.

Figure 38.1

Dynamic stability test



38.4 The deep fryer, cooker/fryer, or oil fondue appliance is to be rotated 180 degrees on the inclined plane and the angle increased until the deep fryer, cooker/fryer, or oil fondue appliance becomes unstable and begins to tip-over. This angle is to be recorded as Beta 1 (β_1). See B of Figure 38.1.

38.5 The deep fryer, cooker/fryer, or oil fondue appliance is to be again heated while on a level surface until the shortening liquefies.

38.6 While energized, the deep fryer, cooker/fryer, or oil fondue appliance is to be oriented on the inclined plane against the low stop in the same position as used for the measurement of Alpha 1.

38.7 The angle of the inclined plane is to be gradually increased (allowing the liquefied vegetable shortening to displace) until instability occurs or the oil starts to spill out. The deep fryer, cooker/fryer, or oil fondue appliance is to be deenergized and held at that angle until the vegetable shortening again solidifies. This angle is recorded as Alpha 2 (α_2). See C of Figure 38.1.

38.8 With the vegetable shortening still solidified, the deep fryer, cooker/fryer, or oil fondue appliance is to be rotated 180 degrees against the low stop, the angle increased until the unit becomes unstable, and then the tip-over angle measured. This angle is to be recorded Beta 2 (β_2). See D of Figure 38.1.

38.9 The base dimension B (the distance between the two fulcrum points) is to be recorded.

38.10 The velocity to cause tip-over is to be calculated from the equation.

$$v = \sqrt{2g(\sqrt{h_2^2 + d_2^2} - h_1)} = \sqrt{2g\left[\frac{h_2}{\cos\alpha_2} - h_1\right]}$$

in which:

g is 32.2 ft/s^2 or 9.81 m/s^2,

h_1 is B/(tanα_1 + tanβ_1),

h_2 is B/(tanα_2 + tanβ_2) and

d_2 is h_2 (tanα_2)

39 Impact after Dynamic Stability Test

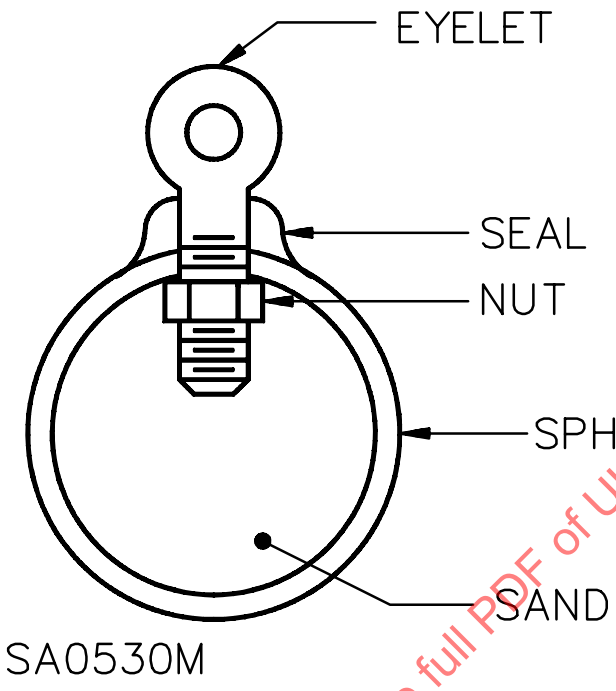
39.1 A deep fryer, cooker/fryer, or oil fondue appliance shall not tip over when subject to a 0.75 ft-lbf (1.02 N·m) impact as described in 39.2.

39.2 A deep fryer, cooker/fryer, or oil fondue appliance is to be subjected to an impact of 0.75 ft-lbf (1.02 N·m). The unit shall be placed on a horizontal softwood surface rigidly fixed for the intended use. In order to prevent sliding, a polyurethane foam material (foam rubber) or the equivalent approximately 1/8 inch (3.2 mm) thick is to be placed and secured underneath the unit. The appliance is to be positioned and loaded to full capacity with the oil solidified in the position obtained during determination of the tip-over angle Alpha 2 (α_2) as referenced in Section 38, Dynamic Stability Test – Deep Fryers, Cooker/Fryers, and Oil Fondues.

39.3 A sphere, illustrated in Figure 39.1, is to be suspended from a cord and allowed to swing as a pendulum in such a manner as to strike the appliance with an impact of 0.75 ft-lbf (1.02 N·m) at a point most likely to cause tip-over. See Figure 39.2 and Figure 39.3.

Figure 39.1

Ball for dynamic stability test



Eyelet – 1-1/2 inches (38 mm) long, No. 10, steel.

Seal – Silicone rubber.

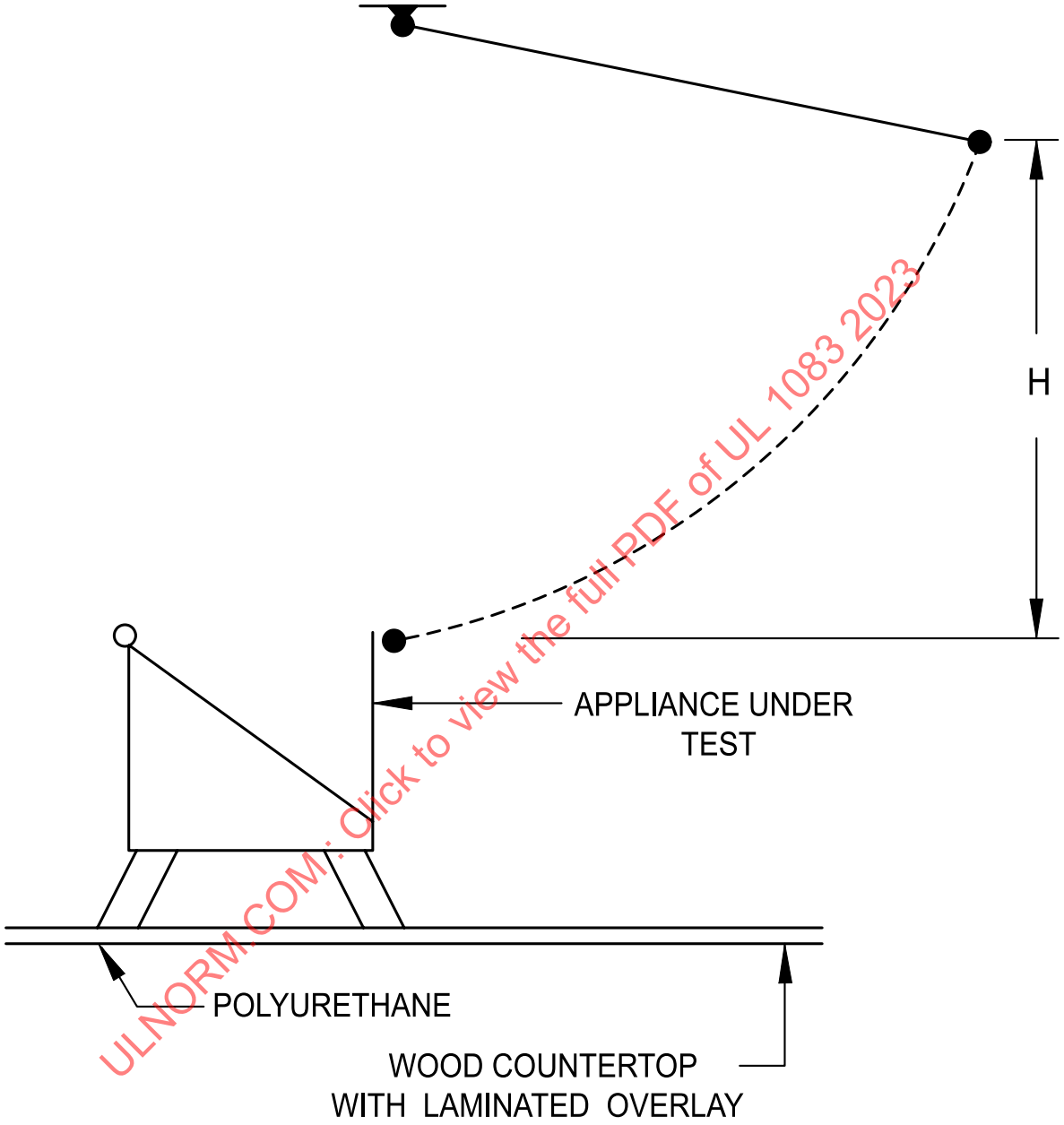
Sphere – Natural rubber or neoprene. Hollow with 1/32 – 3/32 inch (0.8 – 2.4 mm) thick wall. 2-1/8 – 2-3/8 inch (54 – 60 mm) diameter.

Sand – No. 60 core.

Total Weight – 0.30 – 0.36 pounds (136.1 – 163.3 g)

Figure 39.2

Impact test



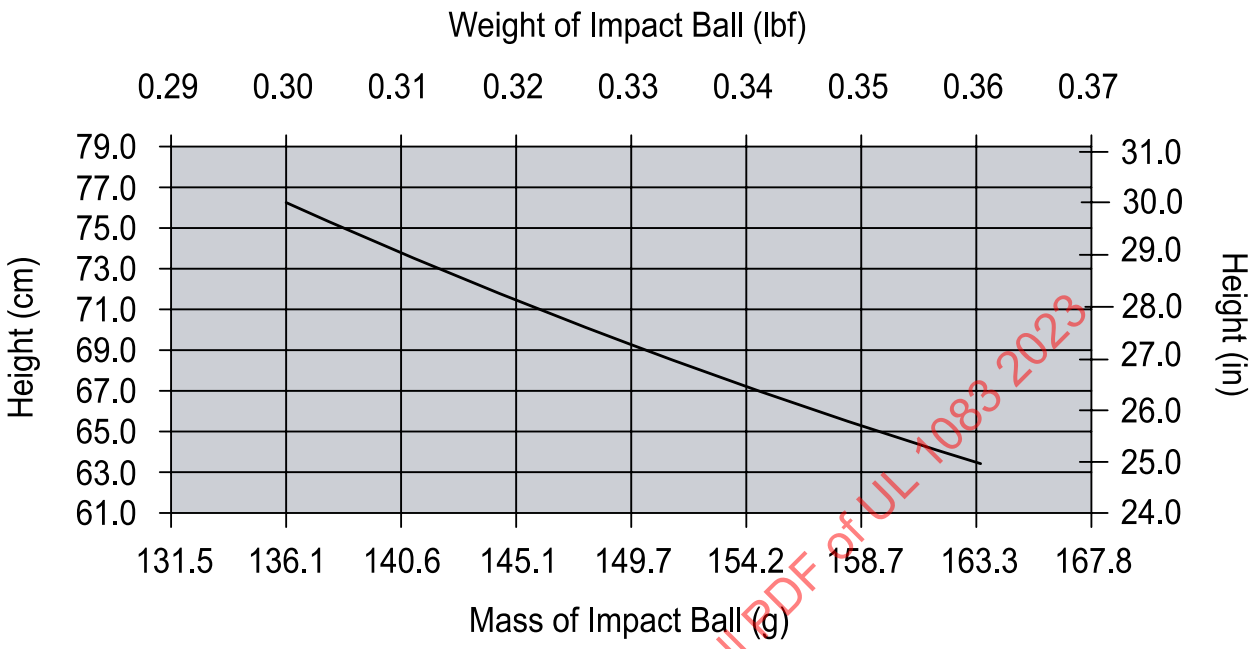
su0285

1) The point at which the sphere impacts the appliance is to cause the most adverse condition for this test.

2) "H" is the height required to produce a 0.75 ft-lbf (1.02 N·m) impact on the appliance when the sphere is at its lowest point of travel.

Figure 39.3

Pendulum drop height (H)



su0286

40 Deep Fryer, Cooker/Fryer, and Oil Fondue Cycling Test

40.1 The handles, feet, or combination handle/feet assembly of a deep fryer, cooker/fryer, oil fondue appliance, and basket handles shall be subjected to the test specified in 40.2 without:

a) Any loosening of the fastening means that results in loss of pan or basket control; or

b) Signs of deterioration of the material. In addition, there shall be no accumulation of oil in the compartment housing the heating element.

40.2 One sample of a deep fryer, cooker/fryer, or oil fondue appliance with basket is to be filled with commercially available peanut oil to the level indicated on the appliance or in the instruction manual. The deep fryer, cooker/fryer, or oil fondue appliance is to be subjected to 100 cycles of operation. Each cycle is to consist of 30 minutes heating followed by 60 minutes cooling. During every 5th cycle, the appliance is to be operated in the cooking mode as described in Normal Temperature Test, Section 31. At the completion of every 5 cycles the appliance is to be drained and allowed to cool to the ambient room temperature.

Exception: Supplemental cooling may be used in lieu of the 60 minute cooling time specified for each cycle, provided the handles and feet of the deep fryer, cooker/fryer, or oil fondue appliance being tested is cooled to the ambient room temperature.

41 Handle and Feet Strength Tests

41.1 Following the test in Deep Fryer, Cooker/Fryer, and Oil Fondue Cycling Test, Section 40, each deep fryer, cooker/fryer, or oil fondue appliance is to be supported in the intended manner by the handle assembly while loaded with lead shot covered with paraffin having a weight equivalent to two times the weight of the maximum intended capacity of vegetable shortening. The test weight is to be distributed so

that the normal horizontal center of gravity is not changed. The handle is to be gripped over a 2 – 4 inch (51 – 102 mm) wide gripping area, centered over the intended gripping area for this test. If more than one handle is furnished, the weight is to be distributed between handles. The samples are then to be rotated, so as to pour in the intended direction, around the axis through the handles from the horizontal through 135 degrees and then back to horizontal for a total of 1000 cycles at a rate of 6 to 8 cycles per minute. There shall be no:

a) Loosening of the fastening means that results in loss of pan or basket control; or

b) Cracking or breaking of the handle, its securing means, or that portion of the enclosure to which the handle is attached.

41.2 Following the test in Deep Fryer, Cooker/Fryer, and Oil Fondue Cycling Test, Section 40, each deep fryer, cooker/fryer, or oil fondue appliance is to be supported for 1 minute in the intended manner by the handle assembly while loaded with lead shot having a weight equivalent to four times the weight of the maximum intended capacity of vegetable shortening. The test weight is to be distributed so that the normal horizontal center of gravity is not changed. The handle is to be gripped over a 2 – 4 inch (51 – 102 mm) wide gripping area, centered over the intended gripping area for this test. If more than one handle is furnished, the weight is to be distributed between handles. There shall be no:

a) Loosening of the fastening means that results in loss of pan or basket control; or

b) Cracking or breaking of the handle, its securing means, or that portion of the enclosure to which the handle is attached.

41.3 Following the test in Deep Fryer, Cooker/Fryer, and Oil Fondue Cycling Test, Section 40, each deep fryer, cooker/fryer or oil fondue appliance is to be supported for 1 minute in the intended manner by the feet assembly while loaded with lead shot having a weight equivalent to four times the weight of the maximum intended capacity of vegetable shortening. The test weight is to be distributed so that the normal horizontal center of gravity is not changed. There shall be no:

a) Loosening of the fastening means that results in loss of pan or basket control; or

b) Cracking or breaking of the handle, its securing means, or that portion of the enclosure to which the handle is attached.

41.4 Following the test in 41.3, each deep fryer, cooker/fryer, or oil fondue appliance utilizing a hanging or swivel type handle assembly is to be placed on a horizontal surface with the handle positioned to the side of the frying basket at its end of travel stop. The handle shall withstand a ball impact by dropping a 2-inch (50.8-mm) diameter steel sphere, weighing 1.18 lb (0.525 kg) from a height that will produce an impact energy of 1.5 ft-lbf (2.03 N·m). The impact shall be applied to cause the maximum torque about the fastening means. Following this ball impact, there shall be no:

a) Loosening of the fastening means that results in loss of pan or basket control; or

b) Cracking or breaking of the handle, its securing means, or that portion of the enclosure to which the handle is attached.

41.5 If screws or nuts accessible to the user are intended to be used to secure the handle and feet assemblies of a deep fryer, cooker/fryer, or oil fondue appliance, they are to be retightened after the tests specified in 41.1 – 41.4, in accordance with the manufacturer's instructions.

Exception: Tamper-proof screws or nuts are not to be retightened.

42 Detachable Power-Supply Cord Separation Test – Deep Fryers, Cooker/Fryers, and Oil Fondues

42.1 A force gauge is to be attached to the detachable power-supply cord of a deep fryer, cooker/fryer, or oil fondue appliance at a distance of 12 inches from the appliance. The appliance is to be held securely in place on a horizontal surface. A steadily increasing pull-out force is to be applied to the detachable power-supply cord directly away from the power-supply cord inlet (0 degrees), at a right angle to the power-supply cord inlet (90 degrees), at a 180 degree angle, and at any angle between 0 and 180 degrees that is intended to represent the worst case. Regardless of the angle of the power-supply cord relative to the inlet, the pullout force shall be in the horizontal direction (parallel to the countertop surface) and perpendicular to the front edge of the countertop. The maximum force required to separate the detachable power-supply cord from the appliance is then to be recorded.

42.2 A deep fryer, cooker/fryer, or oil fondue appliance, at room temperature and with any basket provided removed, is to be placed on a horizontal surface having a coefficient of static friction of 0.20 ±.02 as determined by 42.3 and consisting of laminated thermosetting countertop type material having a smooth matte finish and adhered to a wood base surface rigidly fixed for the intended use. The deep fryer, cooker/fryer, or oil fondue appliance is to be filled with the manufacturers recommended minimum level of oil. A steadily increasing force is to be applied by a force gauge in the horizontal direction and at the height of the power-supply cord inlet. The force required to overcome the static friction of the appliance is then to be recorded.

42.3 The coefficient of static friction of the test surface in 42.2 shall be established by use of a test block weighing 7.55 lbs (33.7 N) and having a surface area of 32 in^2 (206 cm^2). The surface is to consist of 304 stainless steel with a No. 3 finish. The coefficient of static friction is to be determined by the equation: $\mu = F_s/W$ where F_s is the force required to overcome the static friction between the test block and the test surface, and where W is the weight of the test block.

42.4 The maximum force required to separate the detachable power-supply cord from the appliance, as determined in 42.1, shall be at least 5 percent less than the force required to overcome the static friction of the appliance, as determined in 42.2.

43 Thermal Degradation Test

43.1 A thermoset material used for a part of an appliance where risk of fire, electric shock, or injury to persons is involved shall be resistant to thermal degradation at the maximum temperature to which it is exposed during normal use of the appliance. The thermal-aging characteristics of the material may be investigated by any one of the following procedures:

a) The material shall have a temperature index, based on historical data or a long-term thermal aging program, described in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, which indicates acceptability for use at the temperature involved; or

b) The appliance shall be operated with the input voltage adjusted so that the part in question operates at the maximum temperature obtained during the normal temperature test. The test is to be conducted with all temperature controls by-passed for a period of 1000 hours. There shall be no visible degradation of parts at the conclusion of the 1000 hours.

44 Mechanical Endurance Test

44.1 If the normal operation of a waffle-maker-type appliance causes movement of the internal wiring, the appliance shall be capable of operating for 6000 cycles in the intended manner while connected to a supply circuit of the voltage indicated in 44.2. There shall be no electrical or mechanical malfunction and, after the test, the appliance shall comply with the requirements for dielectric voltage-withstand in 33.1 and 33.2.

44.2 In a test to determine whether a waffle-maker-type appliance complies with the requirement in 44.1 (such as in the operation of the upper part of a waffle iron), any appropriate mechanical arrangement may be employed to operate the movable member at a rate of approximately 12 cycles per minute, but, in any case, the cover or movable member is to be so operated that it will reach the actual limits of travel in both directions, each cycle. For hinge designs that provide for movement other than a single pivot point (i.e. allow vertical movement), the test is to be repeated with a spacer of metal or other heat resistant material, equal to the maximum thickness that the movement of the hinge allows and mechanically secured to the bottom cooking surface. The spacer is to be provided as close to the hinge as possible to create a fulcrum point that results in the maximum movement of internal wiring that the construction allows. In the case of an appliance such as a sandwich toaster that has two different stop positions for the hinged cover, 1000 operations out of the total of 6000 are to be made with the cover moved to the wide-open position. The appliance is to be operated at reduced voltage or with resistors in series with the supply circuit so that the temperature produced on the grid will be 210°C (410°F) in the case of a waffle iron and 275°C (527°F) in the case of a sandwich toaster or the like.

45 Broken Element Test

45.1 An open-wire heating element in an appliance shall be constructed and supported 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 articulate probe through any opening in the enclosure.

45.2 To determine compliance with 45.1:

a) The appliance is first to have been operated until fully heated as in the Power Input Test, Section 26, or the temperature tests; and

b) After cutting the heating element, the appliance is to be rotated 360 degrees in the direction most likely to cause contact between the heating element and accessible parts.

46 Abnormal Operation Test

46.1 General

46.1.1 If the conditions of normal operation are not representative also of abnormal conditions likely to be obtained in actual service, an appliance shall not involve a risk of fire or electric shock when operated continuously under such abnormal conditions.

46.1.2 The appliance shall have its voltage selector switch set in any supply circuit voltage position being connected to any one of the rated supply circuits. The combination of selector settings and supply circuit to which the equipment is connected is to be that which develops the most severe operating conditions.

46.1.3 If provided, an externally operable input voltage selector is to be operated for 25 cycles with the appliance operating at the minimum rated voltage and for 25 cycles with the appliance at the maximum rated voltage. Each cycle consisting of moving the voltage selector to its alternate position and back at the rate of six cycles per minute with the voltage selector in each position for 5 seconds. The operating and temperature controls are to be set as to result in the most adverse operating conditions.

Exception: If an externally operable voltage selector switch interlocks with the power switch and cannot be operated with the power switch in the "on" position, the test procedure will be as described in 46.1.4.

46.1.4 For an externally operable voltage selector switch that interlocks with the power switch and cannot be operated with the power switch in the "on" position, the voltage selector is to be operated for 25 cycles each at the maximum and minimum voltages. Each cycle is to consist of the following steps:

a) With the power switch in the "off" position, move the voltage selector to the alternate position;

b) Turn the power switch "on" and operate the appliance for 5 seconds;

c) Turn the power switch "off";

d) Move the voltage selector to the original position; and

e) Turn the power switch "on" and operate the appliance for 5 seconds.

46.1.5 To determine whether a risk of fire or electric shock actually exists, a separate burnout or abnormal test is to be conducted with the appliance operating continuously until the ultimate result has been observed. Unless otherwise indicated below, the test is to be conducted with the applied voltage, method of mounting, and thermostat connection in accordance with 31.1.9 – 31.1.14. Accessible metal parts, those that can be contacted by the probe in Figure 7.2, and metal parts accessible during user-servicing are to be connected to ground through a 3-A fuse. In most cases, continuous operation for 7 to 8 hours will be necessary to determine that the ultimate result has been observed. The appliance is to be placed on white tissue paper on a softwood surface.

46.1.6 An appliance is to be located as close to the walls of the test corner as the construction permits. The test corner is to consist of dull black-painted fir plywood not less than 3/8 inch (9.5 mm) thick, having such width that the wall will extend not less than 2 ft (0.61 m) beyond the physical limits of the appliance. The vertical walls are to meet at a right angle. The test corner is to be provided with a 12-inch (300-mm) deep simulated cabinet bottom, located 16 inches (400 mm) above the counter top. The simulated cabinet bottom is to be of the same material as the test corner walls.

Exception No. 1: The test corner is not required to be used if temperatures obtained are not a factor affecting the results.

Exception No. 2: When an appliance is more than 16 inches (406 mm) high and not more than 22 inches (559 mm) high, the cabinet bottom is to be just over the appliance. When the appliance is more than 22 inches high, the cabinet bottom is to be omitted.

46.1.7 When operated under such abnormal conditions, an appliance is considered to involve a risk of fire if there is any emission of flame or molten metal (other than drops of melted solder), or if the operation of the appliance results in the glowing or flaming of combustible material upon which the appliance may be placed, or that may be adjacent to the appliance.

46.1.8 An appliance is considered to involve a risk of electric shock if the 3-A fuse connected from accessible metal parts of the appliance to ground opens during the test.

46.1.9 After having been subjected to an abnormal test, the appliance is considered to involve a risk of electric shock if the current measured through a 500 ohm resistor connected between an accessible part and ground is more than 5 mA. A solution of hard water (0.5 g of calcium sulphate $CaSO_4 \cdot 2H_2O$ per liter of distilled water) in an amount equal to the capacity of the container is to be poured into the container, and the current is to be measured as quickly as possible thereafter. Liquid need not be added if it is apparent that the appliance will not hold liquid.

46.2 Specific test conditions

46.2.1 For most of the common types of heating appliances, standardized abnormal test conditions are specified in 46.2.2 – 46.7.1.

46.2.2 If an appliance has an exterior surface of glass, ceramic, or comparably brittle material in or on which the heating element is mounted or which is an essential part of the enclosure of live parts, the material shall be capable of withstanding the stresses likely to be encountered in actual service.

46.2.3 Certain specific tests are described in 46.2.4 and 46.2.5, but other tests may be necessitated by the design or intended operation of the appliance.

46.2.4 The glass or ceramic surface shall withstand without cracking or breaking the application of a cloth fully saturated with water (the hard water solution described in 46.1.9) at room temperature, with the appliance in the fully heated condition. The quantity of water involved shall be sufficient to wet the surface completely. The appliance shall then comply with the requirement in 27.1 in a repeat leakage current test, except that the test shall be discontinued when leakage current stabilizes.

46.2.5 An appliance with a horizontal cooking surface of glass or ceramic shall withstand without cracking or breaking the impact of a utensil with a total weight of 4 lb (1.81 kg) and dropped from a height of 6 inches (152 mm), so that it strikes the surface as flatly as possible. The utensil is to have a flat bottom of copper or aluminum, and is to have a diameter of 4-1/4 to 5-1/8 in (108 to 130 mm) with a corner radius of 3/8 in (9.5 mm). A total of 10 drops of the utensil shall be made, and the impacts are to be equally distributed over the surface. The test is to be conducted with the surface at room temperature.

Exception: Breakage or cracking of the surfaces as a result of the test is acceptable if the leakage current, when measured as described in 46.1.9 and acceptable results are obtained following a repeated Dielectric Voltage-Withstand Test as described in Section 33.

46.3 Deep fryers/cooker-fryers/oil fondues

46.3.1 The appliance is to be operated with fresh unused commercially available peanut oil at the recommended level, with the thermostat set at the position that gives maximum heat, and with the appliance initially at room temperature. An oil temperature higher than 390°C (734°F) at any time during the test is not acceptable. The test is then to be repeated with all oil drained from the appliance, but with a residual film of oil within the fat kettle. With reference to 31.1.14, the regulating thermostat is not to be defeated during this test. The cover, if provided, is not to be in place during these tests.

46.3.2 The test in 46.3.1 is to be repeated with all temperature controls other than the temperature limiting device defeated. There shall be no ignition or flash of vaporized oil as a result of this test. For the test, the appliance is to be filled to the recommended level, the basket filled with french fry potatoes and the cover is to be removed.

46.4 Skillets

46.4.1 The appliance is to be tested as indicated in 46.3.1 except that initially 1/2 inch (12.7 mm) of commercially available peanut oil is to be in the skillet.

46.5 Waffle bakers, sandwich grills, hamburger makers, contact grills, and donut makers

46.5.1 One sample of the appliance is to be operated dry with the cover closed and, if construction permits, one sample with the cover open, first 90 degrees if a stop is provided, and then 180 degrees if the position is attainable. The thermostat is to be adjusted to its maximum setting in each case.

46.6 Corn poppers

46.6.1 Two tests shall be made. For the first test, one tablespoon of pure peanut oil shall be placed in the appliance. With the cover in place, the appliance shall be operated from a cold start until ultimate results are obtained.