UL 1026

STANDARD FOR SAFETY

Household Electric Cooking and Food Serving Appliances

UL Standard for Safety for Household Electric Cooking and Food Serving Appliances, UL 1026

Sixth Edition, Dated January 27, 2012

Summary of Topics

This revision of ANSI/UL 1026 dated September 29, 2023 includes the following changes in requirements:

> ***– Addition UL 969A as an alternative to existing permanency of marking requirements for cord tags; 62.1, 62.6, 67.25, 67.27, 69.12 and SB9.1.***
>
> ***– Clarification of Strain Relief Test Requirement; 10.2.2.5 and 10.2.2.6***

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

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated March 10, 2023 and August 25, 2023.

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UL 1026

Standard for Household Electric Cooking and Food Serving Appliances

Prior to the first edition, the requirements for the products covered by this Standard were included in the Standard for Electric Heating Appliances, UL 499.

First Edition – November, 1975
Second Edition – March, 1981
Third Edition – September, 1988
Fourth Edition – July, 1995
Fifth Edition – January, 2007

Sixth Edition

January 27, 2012

This ANSI/UL Standard for Safety consists of the Sixth edition including revisions through September 29, 2023.

The most recent designation of ANSI/UL 1026 as an American National Standard (ANSI) occurred on September 29, 2023. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover household electric cooking and food serving appliances, rated at 250 V or less, other than those mentioned in 1.2, for use in ordinary locations, including appliances intended for casual and permanent outdoor use, in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements do not cover household electric ranges, electrode type appliances, skillets and frying type appliances, fondues, woks, tempuras, corn poppers, coffee makers and brewing type appliances, commercial cooking appliances, microwave cooking appliances, or appliances that are covered in individual requirements that are separate from this Standard.

1.3 For the purposes of this Standard, a requirement that applies to one type of equipment is identified by a specific reference to the type of equipment involved (for example, toaster, rotisserie, or other specific appliance). 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 types of equipment covered by the Standard.

1.4 These requirements do not cover slow cookers intended for outdoor use.

2 Units of Measurement

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

3 Undated References

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

4 Glossary

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

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

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

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

4.5 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.

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

4.7 CONTROL, AUXILIARY – A device or assembly of devices that provides a functional utility, is not relied upon as an operational or protective control, and therefore is not relied upon for safety. For example,

an efficiency control not relied upon to reduce the risk of electric shock, fire, or injury to persons during normal or abnormal operation of the end product is considered an auxiliary control.

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

4.9 CONTROL, OPERATING – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, a thermostat, the failure of which a thermal cutout/limiter or another layer of protection would reduce the risk of electric shock, fire, or injury to persons, is considered an operating control.

4.10 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.)

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

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

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

4.14 INDUCTION HEATING APPLIANCES – Appliances that can heat at least one metallic vessel by means of eddy currents. The eddy currents are induced to the cooking vessel by the electromagnetic field of a coil.

4.15 INDUCTION HEATING SYSTEM – The inductor current waveform is created by a high-efficiency switched DC power supply and 1-2 IGBT switches. The analog to dialogue switches are driven by a microcontroller, which responds to a feedback loop that forces conditions, such as size/shape/material of cooking vessel, current, voltage or temperature, monitored by sensors to correspond to settings established by the user.

4.16 *Deleted.*

4.17 INDUCTION TABLE STOVE (HOTPLATE) – Table Stove that can heat at least one metallic vessel by means of eddy currents. The eddy currents are induced in the bottom of the vessel by the electromagnetic field of a coil.

4.18 LINE-VOLTAGE CIRCUIT – A line-voltage circuit is one involving a potential of not more than 250 V and having circuit characteristics in excess of those of a low-voltage circuit. A circuit derived from a source of supply classified as a line-voltage circuit, by connecting resistance in series with the supply circuits as a means of limiting the voltage and current, is not considered to be a low-voltage circuit as described in 4.19.

4.19 LOW-VOLTAGE CIRCUIT – A low-voltage circuit is one involving a potential of not more the 30 V and supplied by a primary battery, by a standard Class 2 transformer, or by an impedance that, as a unit, complies with all of the performance requirements for Class 2 transformer.

4.20 TOUCH CONTROL – Control actuated by contact or proximity of a finger, with no movement of the contact surface.

CONSTRUCTION

5 General

5.1 If the operation of an appliance involves the generation and confining under pressure of steam or other gas, consideration shall be given to the possibility of an explosion risk incident to such operation. The appliance shall not be acceptable unless its strength is adequate with respect to any explosion risk that may be involved.

5.2 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.

5.3 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.

5.4 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 5.2 (b) – (e).

5.5 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.

6 Frame and Enclosure

6.1 The frame and enclosure of an appliance shall be sufficiently strong and rigid to resist the abuses likely to be encountered during intended 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 that alone or in combination constitute an increase in the risk of fire, electric shock, or injury.

6.2 An appliance shall be provided with an enclosure of material acceptable for the particular application, which shall house all electrical parts, except for a supply cord, and except for an open-wire-element unit as mentioned in 14.3 and 14.4, that may present a risk of fire, shock, or injury under any condition of use. If an appliance is intended for permanent connection to the power supply, the enclosure shall be provided with means for mounting in the intended manner and shall be furnished with any necessary fittings, such as brackets, hangers, or the like.

6.3 In the case of an appliance employing oil or grease in its normal cooking operation, special consideration shall 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.

6.4 If openings for ventilation are provided in the enclosure of an appliance or in an externally mounted component intended for permanent connection to the power supply, they shall be located so that they do not vent into concealed spaces of a building structure such as into false-ceiling space, into hollow spaces in the wall, or the like, when the appliance is installed as intended.

6.5 Among the factors that shall be considered 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 52, for resistance to impact.

Exception No. 1: When considering the abnormal and severe conditions tests of UL 746C, the appliance enclosure is to be subjected to the Abnormal Operation Tests of Section 55.

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 specified in 54.1, shall be conducted.

6.6 A thermoplastic enclosure of an appliance provided with overheating protection (Overheating Protection, Section 28) 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.

6.7 Cast- and sheet-metal portions of enclosure shall be no thinner than indicated in Table 6.1, unless the enclosure is found to be acceptable when judged under considerations as mentioned in 6.5 and 6.8.

6.8 In addition to being considered with reference to the factors mentioned in 6.5, an enclosure of sheet metal shall be judged with respect to its size and shape, the thickness of metal, its acceptability for the particular application, and consideration of the intended use of the appliance.

6.9 Electrical parts of an appliance, except the radiating portion of an open-wire element of an automatic toaster, shall be so located or enclosed that protection against unintentional contact with uninsulated live parts is provided (see also 22.7). Insulated motor brush caps do not require additional enclosure.

Table 6.1
Minimum acceptable thicknesses of enclosure metal

Metal	At small, flat, unreinforced surfaces and at surfaces that are reinforced by curving, ribbing, and the like (or are otherwise of a shape and/or size) to provide equivalent physical strength		At surfaces to which a wiring system is to be connected in the field		At relatively large unreinforced flat surfaces	
	Inches	(mm)	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])	0.032	(0.81)	0.026	(0.66)
Galvanized sheet steel	0.029[a]	(0.74[a])	0.034	(0.086)	0.029	(0.74)
Nonferrous sheet metal	0.036[a]	(0.91[a])	0.045	(1.14)	0.036	(0.91)

[a] Thinner sheet metal may be employed if found to be acceptable when the enclosure is judged under considerations such those mentioned in 6.5.

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

6.11 The requirement in 6.10, 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.

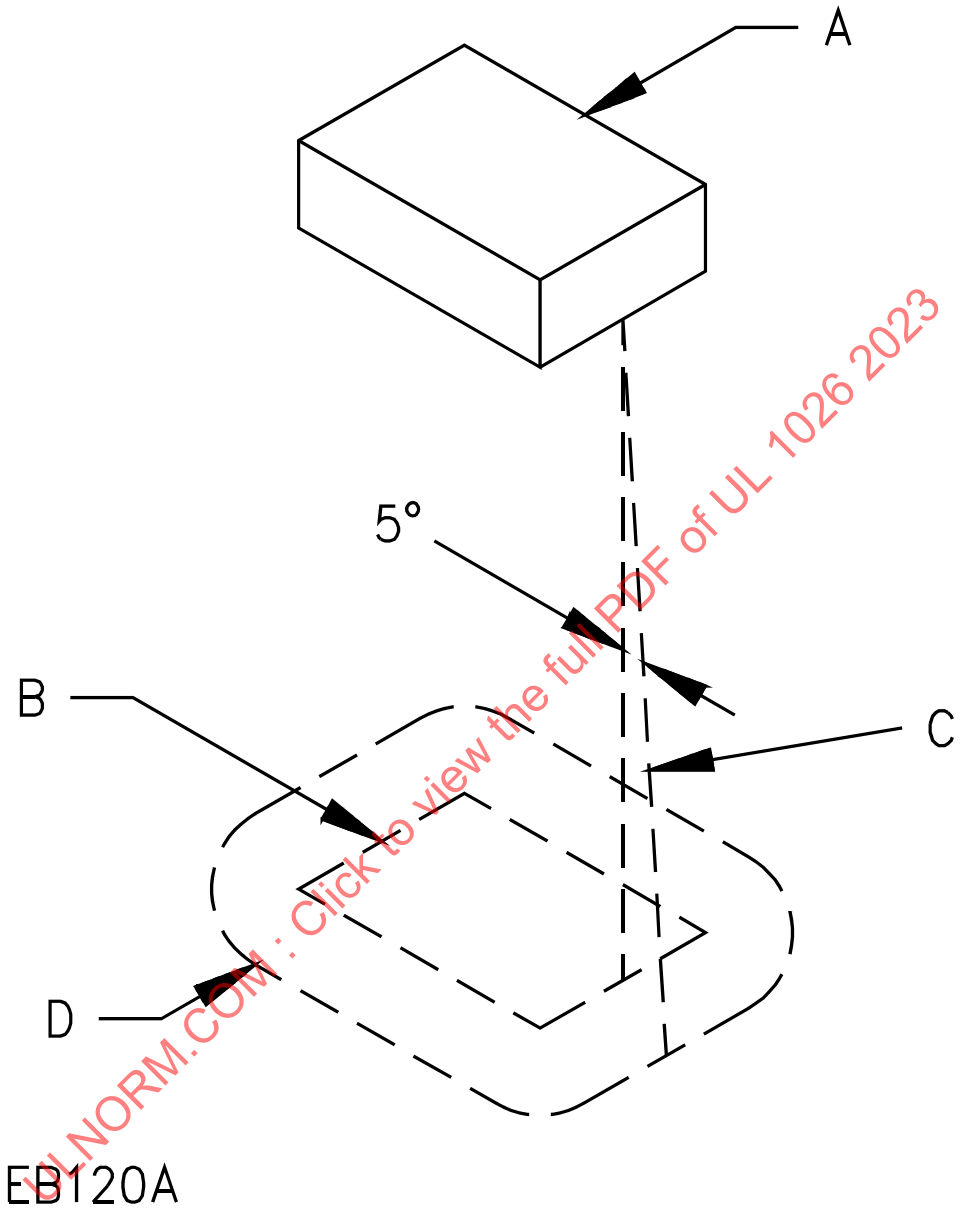
c) Under an unenclosed switch, transformer, relay, solenoid, and the like, unless it can be shown that malfunction of the component is not likely to result in a fire.

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 6.1.

Figure 6.1

Location and extent of barrier



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

B – Projection of outline of component on horizontal plane.

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

1) Tangent to the component;

2) 5 degrees from the vertical; and

3) So oriented 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.

6.12 The barrier mentioned in 6.11, shall be:

a) Of metal, ceramic, or a material that is acceptable as an enclosure in accordance with 6.5;

b) Horizontal; and

c) Located as indicated in Figure 6.1, and shall not have an area less than that described in Figure 6.1.

6.13 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 6.2, 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.

6.14 An opening that has a minor dimension of 1 inch (25.4 mm) or more, in an enclosure, as illustrated in Figure 6.3, 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.

6.15 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).

6.16 During the examination of an appliance in connection with the requirements in 6.9 and 6.13 – 6.15, any part of the enclosure shall be disregarded (opened or removed) – 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. See 6.17.

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 shall remain in place if the appliance is marked in accordance with 67.9.

6.17 With reference to 6.16(b), to determine that a part of an enclosure requires the use of tools for opening or removal, the enclosure or any part of the enclosure that relies for mechanical securement on non-metallic parts, such as plastic tabs or snap-action inserts and posts, shall comply with Non-Metallic Enclosure-Fasteners Test, Section 53.

Exception: An enclosure or enclosure part secured entirely by metallic fasteners (such as screws or rivets) to other enclosure parts is not required to be subjected to this test.

Figure 6.2

Accessibility probe

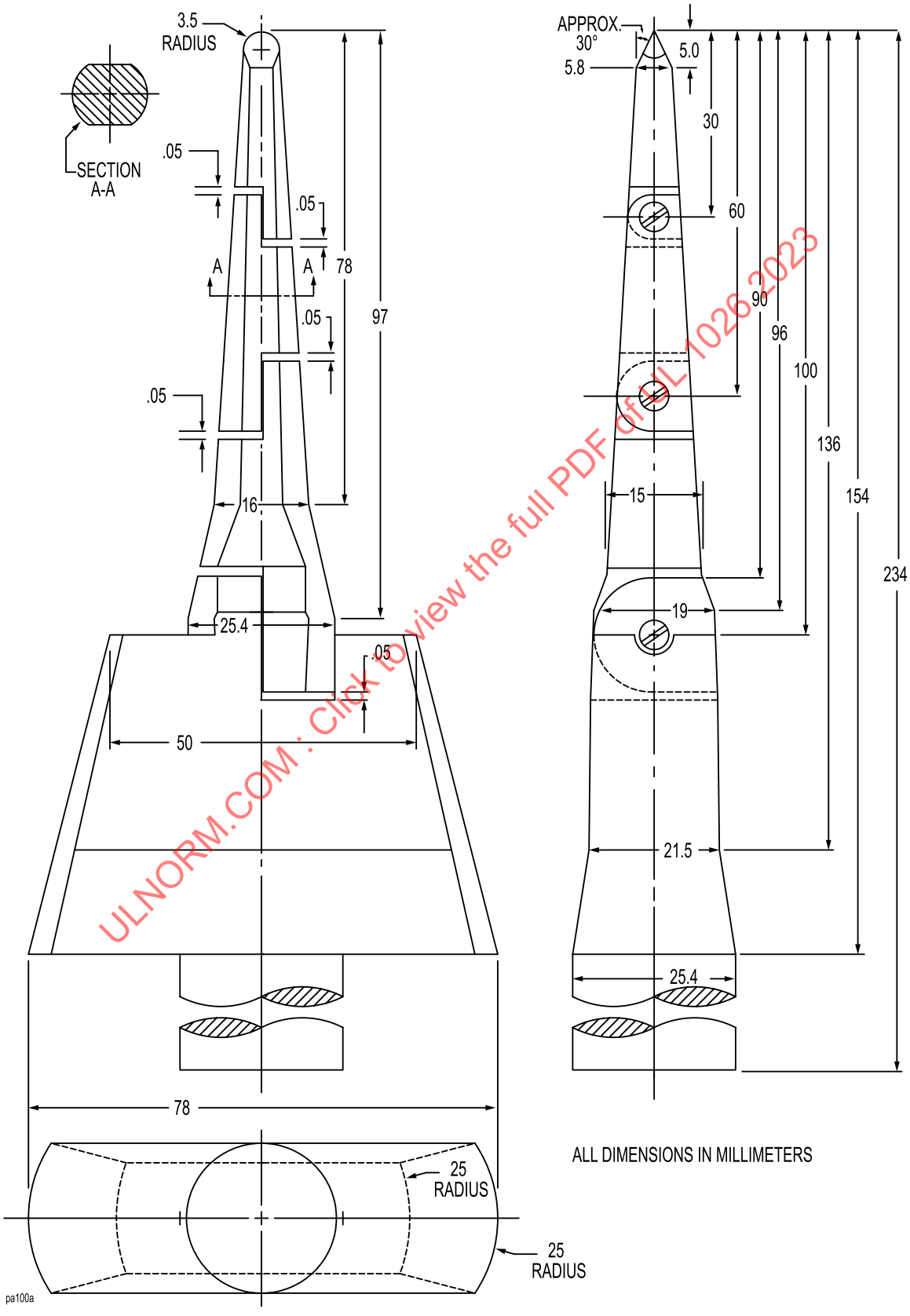
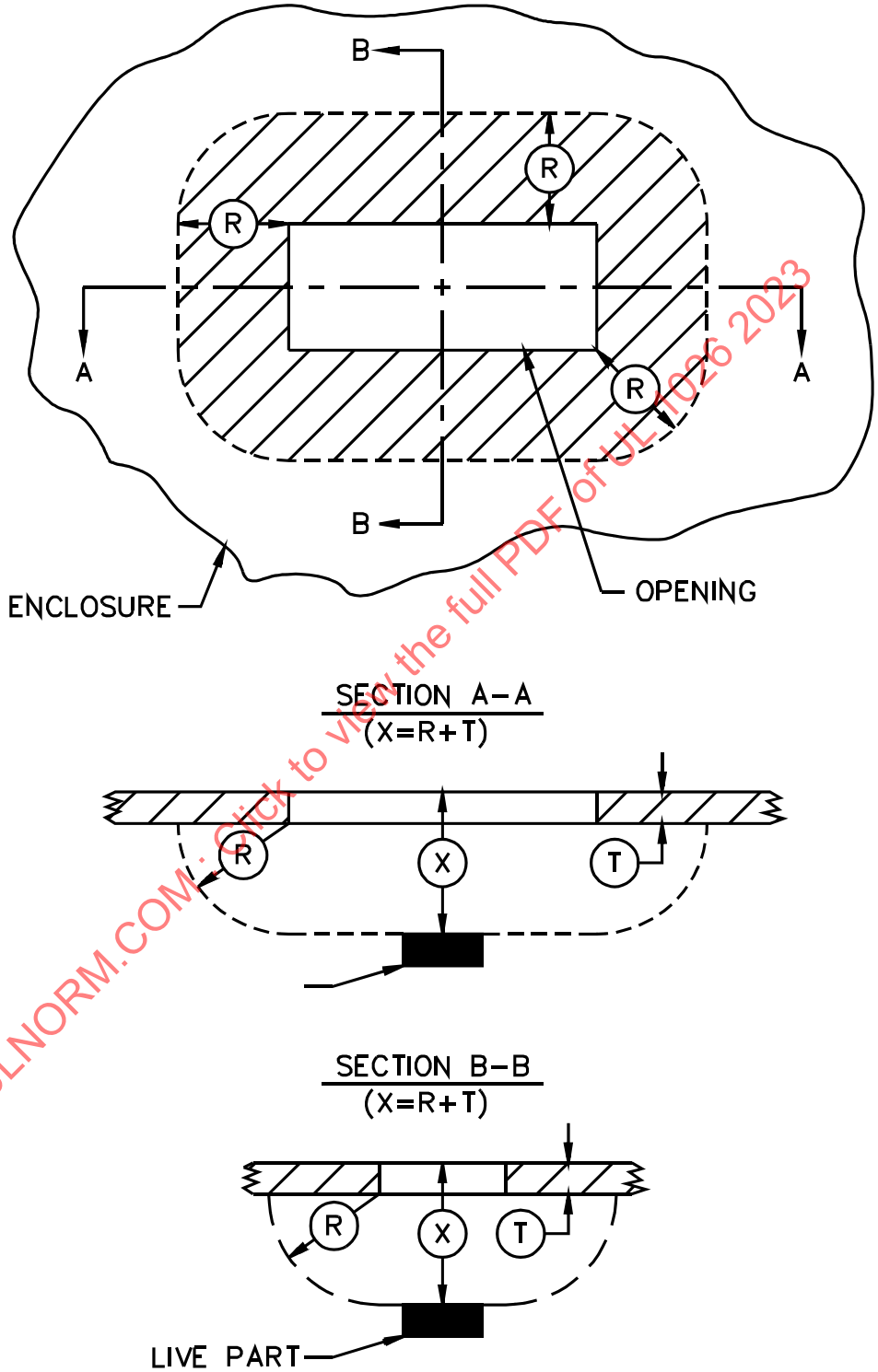


Figure 6.3

Opening in enclosure



Proportions exaggerated for clarity

6.18 Any moving parts, such as rotors of motors, chains, pulleys, belts, and gears, shall be enclosed or guarded to reduce the likelihood of injury to persons.

6.19 With reference to the requirements in 6.18, the degree of protection required of the enclosure depends upon the general construction and intended use of the appliance. The factors to be taken into consideration in judging the acceptability of exposed moving parts are:

a) The degree of enclosure;

b) The sharpness of the moving parts;

c) The likelihood of unintentional contact with the moving parts;

d) The speed of movement of those parts; and

e) The likelihood of fingers, arms, or clothing being drawn into the moving parts (such as at points where gears mesh, where belts travel onto a pulley or where moving parts close in a pinching or shearing action).

6.20 The door or cover of an enclosure shall be provided with means for holding it securely in place in the closed position.

6.21 The door or cover of an enclosure shall be hinged or otherwise attached in an equivalent manner if it gives access to any overload protective device whose functioning requires renewal, or if it is necessary to open the cover in connection with the operation of the protective device. Such a door or cover shall be provided with a latch or the equivalent, and shall be tight-fitting or shall overlap the surface of the enclosure around the opening.

6.22 A component of an appliance 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.

6.23 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.

6.24 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.

7 Assembly

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

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

7.3 Uninsulated live parts shall be secured to the base or surface so that they are prevented from turning or shifting in position as a result of stresses, if such motion may result in a reduction of spacings below the minimum required in 29.1 – 29.4.

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

8 Stability

8.1 The stability of an appliance shall be such that it cannot be readily overturned during intended use.

8.2 A household cooking or warming appliance that is easily carried or conveyed by hand (such as a slow cooker, food warmer, and the like) in which liquids are heated to a temperature greater than 115°F (46°C) shall be placed on a plane inclined at an angle of 15 degrees to the horizontal. All other appliances shall be placed on a plane inclined at an angle of 10 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. Appliances in which liquids are heated shall contain a minimum of 5 ounces (148 mL) of liquid. The appliance shall be prevented from sliding on the inclined surface. The appliance shall not overturn as a result of this test.

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: In certain equipment 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 does not result in unacceptable performance of the appliance.

10 Supply Connections

10.1 Permanently connected appliances

10.1.1 General

10.1.1.1 Except as noted in 10.1.1.2, an appliance intended for permanent connection to the power supply shall have provision for connection of one of the wiring systems that, in accordance with the National Electrical Code, NFPA 70, is acceptable for the appliance.

10.1.1.2 An appliance that is intended to be fastened in place or located in a dedicated space may be acceptable if provided with a short length of appropriate flexible cord and an attachment plug for supply connection. The investigation of such a feature shall include consideration of the utility of the appliance and the necessity of having it readily detachable from its source of supply by means of the attachment plug.

10.1.1.3 The location of a terminal box or compartment in which power-supply connections to a permanently connected appliance are to be made shall be such that these connections can be readily inspected after the appliance is installed as intended.

10.1.1.4 A terminal compartment intended for the connection of a supply raceway shall be attached to the appliance in a manner to prevent turning.

10.1.2 Field wiring terminals

10.1.2.1 An appliance intended for permanent connection to the power supply shall be provided with wiring terminals or leads for the connection of conductors having an ampacity of not less than 125 percent of the current rating of the appliance when the load is continuous (3 hours or more) and not less than the current rating of the appliance when the load will be intermittent.

10.1.2.2 For the purpose of these requirements, wiring terminals are considered to be terminals to which power-supply or control connections are made in the field when the appliance is installed.

10.1.2.3 A wiring terminal shall be provided with a soldering lug or with a pressure wire connector securely fastened in place (for example, firmly bolted or held by a screw), except that a wire-binding screw may be employed at a wiring terminal intended to accommodate a 10 AWG (5.3 mm^2) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in position.

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

10.1.2.5 A wire-binding screw at a wiring terminal shall not be smaller than No. 10, except that a No. 8 screw may be used at a terminal intended for the connection of a 14 AWG (2.1 mm^2) or smaller conductor, and a No. 6 screw may be used for the connection of a 16 AWG (1.3 mm^2) or smaller control-circuit conductor.

10.1.2.6 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050 inch (1.3 mm) thick, except that a plate not less than 0.030 inch (0.8 mm) thick is acceptable if the tapped threads provide equivalent mechanical strength. There shall be two or more full threads in the metal, which may be extruded if necessary to provide the threads.

10.1.2.7 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned in 10.1.2.1, but not smaller than 14 AWG (2.1 mm^2), under the head of the screw or the washer.

10.1.2.8 A wire-binding screw shall thread into metal.

10.1.2.9 An appliance intended for connection to a grounded power-supply conductor and employing a lampholder or element holder of the Edison-screw-shell type, a single-pole switch, or a single-pole automatic control shall have one terminal or lead identified for connection of the grounded conductor of the supply circuit. The terminal or lead so identified shall be the one that is connected to screw shells of lampholders or element holders, and with no connections to single-pole switches or single-pole automatic controls, except as noted in 24.2.

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

10.1.2.11 Except as noted in 10.1.2.12, the free length of a lead inside an outlet box or wiring compartment shall be 6 inches (152 mm) or more if the lead is intended for field connection to an external circuit.

10.1.2.12 A lead may be less than 6 inches (152 mm) in length if it is evident that the use of a longer lead results in an increased risk of fire or electric shock.

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

10.1.2.14 A wire-binding screw intended for connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal, slotted, or both. A pressure terminal connector intended for connection of an equipment-grounding conductor shall be plainly identified by:

a) A marking, such as "G ", "GR ", "GND", "Ground ", "Grounding ", or the like;

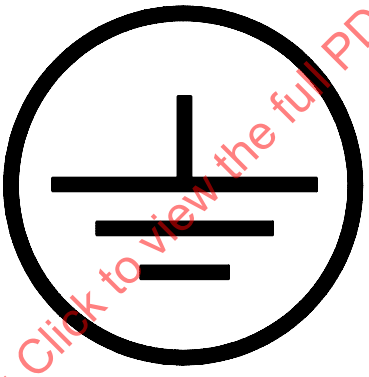
b) A wiring diagram provided on the appliance; or

c) The grounding symbol illustrated in Figure 10.1, on or adjacent to the terminal, or on a wiring diagram provided on the appliance.

The wire-binding screw or pressure terminal connector shall be located so that it does not require removal during normal servicing of the appliance.

Figure 10.1

Grounding Symbol



IEC417, Symbol 5019

10.1.2.15 A terminal solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the proper size for the particular appliance.

10.2 Cord-connected appliances

10.2.1 General

10.2.1.1 A cord-connected appliance (an appliance intended to be connected to the power-supply circuit by means of a flexible cord) shall be provided with a power-supply cord 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 separable cord shall be within the limit indicated in Table 10.1.

10.2.1.2 For a cord-connected appliance, the rating (both current and voltage) of the cord and the fittings, shall not be less than that of the appliance. The current rating of the attachment plug shall not be less than 125 percent of the current rating of the appliance when the load will constitute a continuous load (3 hours or more).

10.2.1.3 An attached flexible cord and the cord in a detachable power-supply cord that is provided with an appliance shall be of a type indicated in Table 10.2, or shall have such properties that it will be at least equally as serviceable for the particular application.

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

10.2.1.3.2 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.

10.2.1.4 An appliance with multiple supply connections, or an appliance and any of its accessories provided with independent supply connections, shall not exceed the rating of the intended branch circuit supply under simultaneous operation. See also 10.1.2.1. Any markings and instructions regarding using separate branch circuits shall be disregarded. Both sources of supply shall be considered to be on the same branch circuit.

Exception No. 1: Not applicable to an appliance with multiple sources of supply, or an appliance and each accessory with independent sources of supply, if provided with a single detachable power-supply cord acceptable for the purpose. No additional detachable power-supply cord shall be provided with either the appliance or the accessory.

Exception No. 2: Not applicable to accessories that comply with all requirements of this Standard independently. Tests are performed with the accessory placed on the supporting surface and not on the appliance.

Table 10.1
Lengths of cord connection

Type of appliance	Kind of cord connection	Minimum acceptable length[a]		Maximum acceptable length[a]	
		Feet	(Meters)	Feet	(Meters)
All counter top or table-top appliances, except slow cookers	Attached cord or detachable power supply cord	2.0	(0.6)	7.0	(2.1)
Slow cookers, for indoor use	Attached cord or detachable power supply cord	2.0	(0.6)	3.0	(0.9)
All appliances intended for outdoor use	Attached cord or detachable power supply cord	1.0	(0.3)	12.0	(3.6)
All appliances not covered above	Attached cord or detachable power supply cord	6.0	(1.8)	7.0	(2.1)

[a] Measured external to the appliance and including the fittings but excluding the blades on the attachment plug.

Table 10.2
Acceptable types of cord and limitations on their use

Appliance on which the cord is to be used	Cords acceptable where temperatures are more than 121°C (250°F) on any surface that the cord is likely to touch when the appliance is used as intended	Cords acceptable where temperatures are 121°C (250°F) or less on any surface that the cord is likely to touch when the appliance is used as intended
Except as noted below, table stoves, toasters and other appliances that are not intended for use outdoors	HPD, HPN, HSJ, or HSJO	HPD, HPN, HSJ, HSJO, SP-2, SPE-2, SPT-2, SV, SVE, SVO, SVT, SVTO, SJ, SJE, SJO, SJT or SJTO
Barbecue-spit motor	SJE, SJO, SJT, or SJTO	SJE, SJO, SJT, or SJTO
Appliances intended for outdoor use	HSJW or HSJOW	HSJW, HSJOW, SJW, SJEW, SJOW, SJTW or SJTOW

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

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

10.2.1.7 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.

10.2.1.7.1 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 6; Assembly, Section 7; 10.2.3; Current-Carrying Parts, Section 11; and Spacings, Section 29, of this end product Standard.

10.2.1.7.2 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.

10.2.1.8 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 10.2, and the polarity identification of the flexible cord shall comply with Table 10.3.

10.2.1.9 The conductor of the power supply cord that is intended to be grounded shall have the following items connected to it:

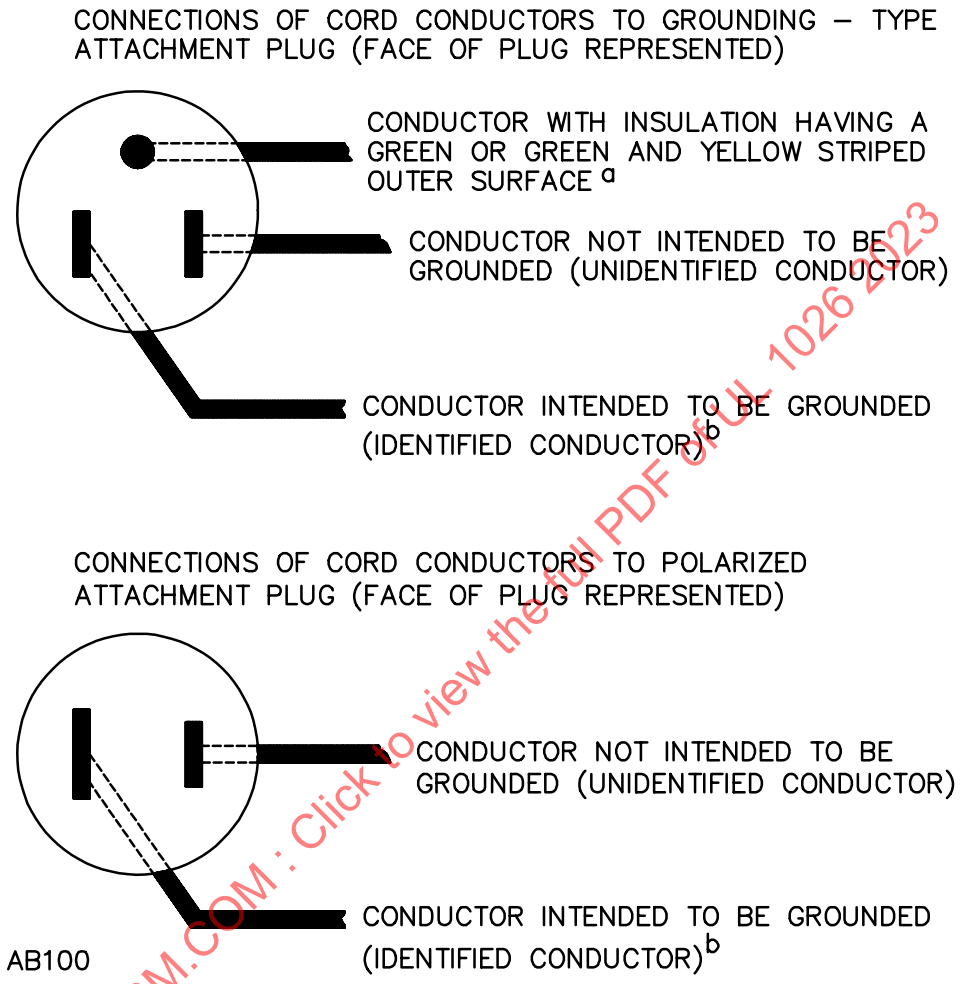
a) The screw shell of an Edison-base lampholder; and

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

Table 10.3, identifies the supply cord conductor intended to be grounded.

Figure 10.2

Connection to attachment plug



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

[b] Signifies a conductor identified in accordance with Table 10.3.

Table 10.3
Polarity of 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 of separators	D[b]	White or gray	Color other than white or gray
Other means	E[c]	Tin or other white metal on all strands of the conductor	No tin or other white 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 for Type SPT-1 and SPT-2 cords.

[d] A wire finished to show a green cord with or without one or more yellow stripes or tracers is to be used only as an equipment grounding conductor. See 31.3 and Figure 10.2.

[e] For jacketed cords.

10.2.2 Strain relief

10.2.2.1 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.

10.2.2.1.1 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.

10.2.2.2 If wood, pressed board, or other fibrous material 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.

10.2.2.3 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 47.

10.2.2.4 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 that may cause abrasion of the insulation on the conductors.

10.2.2.5 The strain-relief means provided on an attached flexible cord, when tested in accordance with 10.2.2.6, shall withstand for 1 minute, without transmitting stress to the electrical connections, a pull of 35 lbf (156 N) applied to the cord.

10.2.2.6 The cord shall be cut closest to the electrical connections to allow visibility to the conductors within the jacket. The specified force is to be applied to the cord and supported by the appliance so that the strain-relief means is stressed from any angle that the construction of the appliance permits. The means of affording strain relief is not acceptable if either:

a) The cord jacket has moved such that it cannot meet the electrical connections without stress; or

b) The conductors have been displaced by more than 0.078 in (2 mm) within the cord jacket.

10.2.3 Pin terminals

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

10.2.3.2 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 6.2, should not touch any current-carrying pin while the probe is inserted through any opening with the appliance in any position.

10.2.3.3 The plug used in accordance with 10.2.3.2(b), is to be the plug supplied with the appliance.

10.2.3.4 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-connector body. The plug that these pins accommodate shall be appropriate for the particular application.

10.2.3.5 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.

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

10.2.3.7 The requirement in 10.2.3.6, is intended primarily to provide for maintenance of spacings as given in 29.1 and Table 29.1 and Table 29.2, and to provide for the maintenance of proper spacings between pin terminals. Under this requirement, consideration is also given to the means for locking terminals in position to maintain tightness.

10.2.3.8 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 10.4.

10.2.3.9 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.

10.2.3.10 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.

Table 10.4
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 5 A at 250 V and 10 A at 125 V	2	In line	1/2 (12.7)	0.156 ±0.005 (3.97 ±0.13)	9/16 – 5/8 (14.3 – 15.9)
Flatiron plug rated 5 A at 250 V and 10 A at 125 V	2	In line	11/16 (17.5)	0.188 ±0.005 (4.76 ±0.13)	3/4 – 7/8 (19.0 – 22.2)
Jumbo appliance plug rated 10 A at 250 V and 15 A at 125 V	2	In line	1-1/16 (27)	0.188 ±0.005 (4.76 ±0.13)	3/4 – 7/8 (19.0 – 22.2)
Reversible plug (for two-heat control) rated 10 A at 250 V and 15 A at 125 V[a]	3	In line	7/8 (22.2)	0.188 ±0.005 (4.76 ±0.13)	3/4 – 7/8 (19.0 – 22.2)
Reversible plug (for two- or three- heat control) rated 10 A at 250 V and 15 A at 125 V[a]	3	One pin at apex of an equilateral triangle	7/8 (22.2)	0.188 ±0.005 (4.76±0.13)	3/4 – 7/8 (19.0 – 22.2)

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

10.2.4 Bushings

10.2.4.1 At a point where a flexible cord passes through an opening in a wall barrier or enclosing case, there shall be a bushing or the equivalent that shall be secured in place, and shall have a smooth, well-rounded surface against which the cord may bear. If Type SP-2, SPT-2, or other cord lighter than Type HSJ is employed, and 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.

10.2.4.1.1 In addition to the requirements in 10.2.4.1, Insulating bushings shall comply with the Standard for Insulating Bushings, UL 635.

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

10.2.4.3 Ceramic materials and some molded compositions are usually acceptable for insulating bushings, but a separate bushing of wood, hot-molded shellac and tar composition, or rubber material (other than in a motor) 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 will not be affected adversely by conditions of ordinary moisture.

10.2.4.4 A separate soft-rubber, neoprene, or polyvinyl chloride bushing may be employed in the frame of a motor or in the enclosure of a capacitor physically attached to a motor (but not elsewhere in an appliance, except as indicated in 10.2.4.5) provided that:

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

b) The bushing is located so that it is not exposed to oil, grease, oily vapor, or other substance having a deleterious effect on the compound employed.

10.2.4.5 A bushing of any of the materials mentioned in 10.2.4.4, may be employed at any point in an appliance if used in conjunction with a type of cord for which an insulating bushing is not required, and if the edges of the hole in which the bushing is mounted are smooth and free from burrs, fins, and the like.

10.2.4.6 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 (0.8 mm) thick, 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) Terminal parts and other parts of a motor and its governor (if any);

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

d) 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 an appliance, all live parts shall be located or protected so that they are not subjected to dripping if the reservoir fails, 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 a size and type that are acceptable for the particular application, when considered with respect to:

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

b) Its 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 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 Chapter 3, 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 an 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 an appliance is considered to be protected as required in 12.2.1, if when judged as if it were film-coated wire, the wiring is acceptable according to 6.9 – 6.13. Internal wiring not 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 may be in proximity to combustible material or may be subjected to mechanical injury, it shall be armored cable or in rigid metal conduit, electrical metallic tubing, metal raceway, or shall otherwise 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 cannot 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. A flexible cord used for external inter-connection as mentioned in 12.2.1, shall be provided with strain relief and bushings in accordance with 10.2.2.1 – 10.2.2.6 and 10.2.4.1 – 10.2.4.6, unless the construction is such that the cord will be protected from stress or motion.

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 acceptable electrical contact. A soldered connection shall be made mechanically secure before being soldered if breaking or loosening of the connection results in 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 spacing between the splice and other metal parts of the appliance is not 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 10.1.2; Current-Carrying Parts, Section 11; Electrical Insulation, Section 14; and Spacings, Section 29, of this end product Standard. This exception does not apply to protective conductor terminal blocks.

12.4 Separation of circuits

12.4.1 Unless provided with insulation rated for the highest voltage involved, insulated conductors of circuits connected to separate sources of supply shall be separated by barriers or segregated. Except as

described in 12.4.3, an insulated conductor of one circuit shall be separated or segregated from any uninsulated live part of a different circuit.

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

12.4.3 Field-installed conductors of any circuit shall be segregated by barriers from:

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

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

1) A construction in which field-installed conductors may make contact with wiring terminals is acceptable provided that Type T, TF, or equivalent conductors are installed; and

2) A construction in which field-installed conductors that do or may have insulation less than the types of wire mentioned in (1) may make contact with low-voltage wiring terminals (see 4.19) is acceptable, provided that the short-circuiting of such terminals does not result in risk of fire or electric shock.

12.4.4 With respect to 12.4.3(a), if the intended uses of an appliance are such that in some applications a barrier is required, a removable barrier or one having openings for the passage of conductors may be employed, provided instructions for the use of the barrier are a permanent part of the appliance, and complete instructions in conjunction with a wiring diagram may be acceptable instead of a barrier if, upon investigation, the combination is found to provide the required separation.

12.4.5 Segregation of field-installation conductors from other field-installation conductors and from uninsulated live parts of an appliance connected to different circuits may be accomplished by arranging the location of the openings in the enclosure for the various conductors (with respect to the terminals or other uninsulated live parts) so that there is no likelihood of the intermingling of the conductors or parts of different circuits. If the number of openings in the enclosure does not exceed the minimum required for the proper wiring of the appliance, and if each opening is located opposite a set of terminals, it is to be assumed (for the purpose of determining whether the appliance complies with the requirement in 12.4.3) that the conductors entering each opening will be connected to the terminals opposite the opening. If more than the minimum number of openings are provided, the possibility of conductors entering at points other than opposite the terminals to which they are intended to be connected and contacting insulated conductors or uninsulated current-carrying parts connected to a different circuit is to be investigated. To determine whether the appliance complies with the requirement in 12.4.3, it is to be wired as it would be in service, and in doing so, a reasonable amount of slack is to be left in each conductor, within the enclosure, and no more than average care is to be exercised in stowing this slack in the wiring compartment.

12.4.6 If a barrier is used to provide separation between the wiring of different circuits, it shall:

a) Be of metal or of insulating material;

b) Be reliably held in place; and

c) Be of a mechanical strength to withstand any anticipated mechanical exposure.

Unclosed openings in a barrier for the passage of conductors shall not be larger in diameter than 1/4 inch (6.4 mm) and shall not exceed in number, on the basis of one opening per conductor, the number of wires which will need to pass through the barrier. The closure for any other opening shall present a smooth surface wherever an insulated wire may be in contact with it, and the area of any such opening, with the closure removed, shall not be larger than required for the passage of the necessary wires.

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

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. When a fiberglass rope heating element is provided, it shall be secured within the unit by a positive means such as screws, lock washers/nuts, rivets or the equivalent so that with minor loosening, disengagement of the heating element does not result in the risk of fire or shock as determined by the Abnormal Operation Test, Section 55.

13.3 Except for an automatic toaster, a heating element in an appliance that may be contacted by the user during intended use or cleaning shall not be of the open wire construction. An automatic toaster employing open wire heating elements and provided with a mode of operation that does not require the operation of both heating elements within a toaster slot meets the intent of the requirement provided at least one of the heating elements within the slot is visibly glowing.

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 6.9, 6.13, and 6.14, and the Broken Element Test, Section 46.

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.

13.6 An appliance in which the heating element is intended for operation only in an air blast shall be wired or controlled so that the element can be operated only while under the cooling effect of the blast. An appliance in which the cooling effect of the motion of a part is necessary for acceptable temperatures shall be wired or controlled so that the element cannot be operated without such motion.

13.7 The heating elements of an automatic toaster shall de-energize independently of the movement of a simulated toast load, as determined by 55.2.5.4.

14 Electrical Insulation

14.1 Insulating washers, bushings, and the like that are integral parts of an appliance, and bases or supports for the mounting of current-carrying parts, shall be of a moisture-resistant material that is not damaged by the temperatures to which they are subjected under conditions of actual use. Molded parts shall be constructed so that they have the mechanical strength and rigidity necessary 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 of these factors shall be considered with respect to thermal aging. The appropriate tests in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, see Electrical Insulation Section, shall be used to evaluate a material for the above mentioned properties.

Exception: Thermoset materials need not be subject 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 54.1, 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 results 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 44.1.

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, and shall have a suitable temperature class.

15 Thermal Insulation

15.1 Thermal insulation, if employed, shall be of such a nature and located and mounted or supported so that it is not adversely affected by any intended operation of the appliance. See 41.1.27.

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

15.3 Some types of mineral-wool thermal insulation contain conductive impurities in the form of slag, which makes its use unacceptable if in contact with uninsulated live parts. See 43.1.

16 Motors and Transformers

16.1 A motor shall be appropriate for the particular application, and shall be capable of handling its maximum intended load without risk of fire, electric shock, or personal injury.

16.1.1 A motor shall comply with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

16.1.2 Motors located in a low voltage circuit are evaluated for the risk of fire and personal injury in accordance with the applicable requirements of this end product Standard.

16.2 A motor winding shall resist the absorption of moisture and shall be formed and assembled in a workmanlike manner.

16.3 With reference to the requirement in 16.2, film-coated wire is not required to be additionally treated to resist absorption of moisture. Fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials shall be provided with impregnation or otherwise treated to resist moisture absorption.

16.4 An automatic bread maker that performs both a heating and motor-operated food preparation function, shall have the motor-operated food preparing function evaluated in accordance with the requirements for a dough maker, in the following Sections of the Standard for Motor-Operated Household Food Preparing Machines, UL 982: Capacitors, Starting Current Test, Normal Temperature Test, Abnormal Operation Test, Enclosures of Polymeric Material for Portable Appliances, and Thermoplastic Coil Forms and Thermoplastic Insulating Material.

16.5 A transformer in a circuit involving a risk of fire or electric shock shall comply with the requirements the following:

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

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

c) The Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

Exception No. 1: A transformer located within another component (for example, a power supply or temperature control) need not comply with this requirement provided that the overall assembly meets the requirements for that component.

Exception No. 2: A transformer located in a Pollution Degree 1 or 2 environment (see Table 26.3) need not comply with this requirement provided that the transformer complies with the requirements in the Standard for Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411.

16.5.1 Neon sign transformers shall comply with the Standard for Neon Transformers and Power Supplies, UL 2161.

16.6 A low voltage component fan provided in an induction heating appliance shall comply with the requirement in the Standard for Electric Fans, UL 507.

17 Motor-Running Overcurrent (Overload) Protection

17.1 The following appliances in which a 1 hp or smaller motor is used shall incorporate thermal or overload protection that prevents the motor from attaining excessive temperatures under any operating conditions:

a) A remotely or automatically controlled appliance; and

b) A permanently connected, continuous-duty, manually started appliance.

An impedance-protected motor is not required to have additional thermal or overload protection.

17.2 An appliance intended to be automatically or remotely controlled, and employing a motor rated at more than 1 hp, shall incorporate thermal or overcurrent protection.

17.3 Fuses shall not be used as motor-overload-protective devices unless the motor is protected by the largest size of fuse that can be inserted in the fuseholder.

17.4 Thermal protection devices integral with the motor shall comply with one of the following:

a) The Standard for Overheating Protection for Motors, UL 2111;

b) The Standard for Thermally Protected Motors, UL 1004-3; or

c) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2 Particular Requirements for Thermal Motor Protectors, UL 60730-2-2; in conjunction with the Standard for Thermally Protected Motors, UL 1004-3 (to evaluate the motor-protector combination).

17.5 Impedance protection shall comply with one of the Standard for Impedance Protected Motors, UL 1004-2

17.6 Electronic protection integral to the motor shall comply with the Standard for Electronically Protected Motors, UL 1004-7.

17.7 Except as indicated in 17.6, electronically protected motor circuits shall comply with one of the following:

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

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

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

Exception: Compliance with the above standards is not required for an electronically protected motor circuit if there is no risk of fire, electric shock, or injury to persons during abnormal testing with the motor

electronic circuit rendered ineffective; compliance with the applicable requirements of this end product Standard is then required.

18 General (Short-Circuit and Ground-Fault) Overcurrent Protection

18.1 Overcurrent protection at not more than 20 A shall be provided by means of a circuit breaker or fuse, as a part of a heating appliance, for each general-use receptacle circuit and each lampholder circuit independent of a heating element, included in the appliance, unless the appliance would be properly connected to a branch circuit rated at 20 A or less.

18.2 The overcurrent protection mentioned in 18.1, shall be of a type indicated as being acceptable for branch-circuit protection.

18.3 A fuseholder or circuit breaker provided as a part of an appliance shall be acceptable for the particular application and shall not be accessible from the outside of the appliance without opening a door or cover, except that the operating handle of a circuit breaker may project outside of the enclosure. A fuseholder shall be so installed that no uninsulated live parts other than the screw shell or clips of the fuseholder are exposed to contact by a person removing or replacing a fuse. If the fuseholder is intended to be accessible only to a serviceman, uninsulated live parts other than the screw shell or clips may be exposed if they are guarded, or the fuseholder shall be located to prevent unintentional contact with these live parts.

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

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

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

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

18.7 Circuit breakers having integral ground fault circuit interrupter capability for protection against electrical shock shall additionally comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943.

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

19 Overcurrent and Over-Temperature Protection

19.1 If an appliance is provided with a replaceable overcurrent and/or over-temperature protective device, the device shall be secured in place and shall be located so that it is accessible for replacement without damaging other connections or internal wiring. See 67.9.

19.2 If an appliance is provided with a fusible device, the device 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 41.1.14, and operated in a normal position to cause abnormal heating.

19.3 To determine whether a fusible device complies with the requirement in 19.2, the appliance is to be operated with separate devices five times as described in 19.2, while any other thermally operated control devices in the appliance are short-circuited. Each device is required to perform acceptably. During the test, the enclosure is to be connected through a 3-Amp fuse to a supply conductor not containing the device.

20 Lampholders

20.1 If an appliance intended for permanent connection to the power supply or an appliance equipped with a polarized or grounding type attachment plug is intended to be connected to the grounded conductor of a power-supply circuit, a lampholder supplied as part of the appliance shall be wired so that the screw shell is connected to the grounded conductor.

20.2 Except as noted in 20.3, a lampholder shall be constructed and installed so that uninsulated live parts other than the screw shell are not exposed to contact by persons removing or replacing lamps in user service.

20.3 The requirement in 20.2, does not apply if, in order to remove or replace a lamp, it is necessary to dismantle the appliance by means of tools.

20.4 A medium-base lampholder or screw-shell receptacle shall not be used as a holder for a heating element rated at more than 6 A or 660 W, except that a screw with a left-handed thread may be used with a heating element rated at not more than 10 A.

20.5 Except as noted in 20.6, a screw-shell lampholder for an infrared lamp shall be of the unswitched, medium-base type, and used with a 300-W or smaller lamp.

20.6 A lamp-and-lampholder combination need not comply with the requirement in 20.5, if no unacceptable temperature is produced on any of the components in the normal-temperature test, and if the switching mechanism of a switched lampholder is capable of performing acceptably without undue burning, pitting, or the like.

20.7 A female screw shell used as a holder for a heating element shall be of copper or of a copper-base alloy and shall be plated with nickel or equivalent oxidation-resistant metal.

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

21 Power-On Indicator – Toaster Ovens, Toaster Oven/Broilers

21.1 A toaster-oven and toaster-oven/broiler shall be provided with power-on and power-off indicators. The power-on indicator shall be readily visible and distinguishable from any off position indicator. The power-on indicator shall clearly indicate that the appliance is on.

21.2 The power-on indicator shall be an illuminated switch or pilot light. An ordinary on/off switch position marking alone is unacceptable. The power-on indicator shall remain on during any operating condition (including cycling of the thermostat) of the appliance.

21.3 At least one means shall be provided, other than unplugging the cord, to turn the appliance off.

22 Switches

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

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

22.3 It is recommended that all switches be of an indicating type.

22.4 A switch on a cord-connected toaster shall be of such a type and connected so that it disconnects any open-wire element or elements that it controls from all conductors of the supply circuit.

22.5 The requirement in 22.4, 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.

22.6 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 10.3, specifies the identification of the power supply cord conductor intended to be grounded.

22.7 A switch or other device controlling one or more elements of an appliance intended for permanent connection to the power supply shall be of such construction that opening the switch disconnects all of the ungrounded conductors of the supply circuit, unless there are no live parts exposed to unintentional contact when the switch is open or unless it is apparent that such parts are live parts.

22.8 A switch or other means of control intended to provide for the use of a limited number of elements at one time shall be located or of such a type that the user cannot readily change the connections to energize more elements than intended.

22.9 A switch controlling a lampholder shall be acceptable for use with tungsten-filament lamps.

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

22.11 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) Item (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.

22.12 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 – 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.

22.12.1 Additionally, if a clock operated switch incorporates a stay-on feature which is activated in the same direction as the countdown to OFF, two operations are required to engage the stay-on feature.

22.12.2 The clock-operated switch referenced in 22.12.1 shall turn the appliance OFF with a single action or operation.

22.13 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 Solid-State Controls for Appliances, UL 244A; or

b) The Standard for Automatic Electrical Controls – 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.

22.14 An induction table stove or similar appliances with touch control subject to spillage, shall be constructed so that inadvertent operation of touch controls is unlikely when there is spillage of liquids or when a damp cloth is placed on the control panel.

22.15 Appliances incorporating touch control shall require at least two manual operations to switch on a heating element but only one to switch it off. Touching the contact surface of the switch control at the same point twice is not considered to be two operations.

22.16 Induction table stoves shall be constructed so that they can only be operated with recommended vessel placed on the cooking zone.

22.17 Automatic shutoff means shall be provided on an induction heating appliance that will deenergize the appliance when a cooking vessel is removed, even though the switch is in the "on" position. The shutoff means shall incorporate a manual reset feature that requires a deliberate resetting action (see also 22.15) to reenergize the appliance when the vessel is replaced.

22.18 A cord-connected automatic toaster shall be provided with a non-automatically resettable supplemental operating control which shall function in the event of failure of any circuit or component which de-energizes the heating elements at the end of normal operation. The supplemental operating control shall include a switch, or fusible or other device, which physically disconnects the ungrounded conductor of the power supply independently of all other switching devices. The supplemental operating control shall function no more than 60 seconds after the maximum operation time as determined in 60.4.2.

Exception: A supplemental operating control is not required if there is no ignition of the food load and no ignition of the indicator panel when tested as described in 55.2.5.2 except with all means for disconnecting any heating element shunted out of the circuit . The unit shall operate in this condition for 30 minutes.

22.19 A cord-connected automatic toaster with touch control, or an appliance with touch control where unintentional operation of moving parts that results in injury, shall be constructed to reduce the risk of unintentional operation. The touch control shall comply with all of the following requirements:

a) At least two manual operations to start operation of appliance. Touching the contact surface of the switch control at the same point twice is not considered to be two operations;

b) A plainly identified one-step STOP function readily visible during operation and distinguish from other functions;

c) A flashing light (or other visual indicator) to indicate when the touch screen is in a condition where a single touch is needed to initiate operation of the appliance (after Step 1);

d) A time-out function on the first step of no longer than 30 seconds;

e) Provided with a flashing light and instructions as specified in 71.6 when a single touch is needed to initiate operation of the appliance; and

f) Glass Window or Door Impact Test, Section 50 followed by Dielectric Voltage Withstand Test, Section 44 between live parts and accessible touch screen surfaces closely wrapped in metal foil.

22.20 With respect to 22.19, after the operation of the appliance is manually stopped, or after automatically stopping at the completion of a programmed sequence, the appliance shall return to a condition requiring a two-step function to initiate operation.

22.21 A touch control on an appliance as specified in 22.19(a), shall additionally be subjected to the following without loss of the two-step ON function:

a) Component Failure Test, 55.2.10,

b) Electrostatic Discharges in accordance with Electromagnetic compatibility (EMC) – Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test, IEC 61000-4-2, test level 4 being applicable. Ten discharges having a positive polarity and ten discharges having a negative polarity are applied at each preselected point, and

c) Radiated Emission in accordance with Electromagnetic compatibility (EMC) – Part 4-3: Testing and Measurement Techniques – Radiated, radio-frequency, electromagnetic field immunity test, IEC 61000-4-3. The frequency ranges tested shall be:

1) 80 MHz to 1000 MHz, test level 3;

2) 1.4 GHz to 2.0 GHz, test level 3;

3) 2,0 GHz to 2,7 GHz, test level 2.

NOTE: The dwell time for each frequency is to be sufficient to observe a possible malfunction of the protective electronic circuit.

23 Dual Voltage Appliance

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

23.2 If the appliance is constructed such 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.

23.3 An appliance that can be set to different rated supply circuit voltages shall be provided with the statement required by 71.10.

24 Automatic Controls and Control Circuits

24.1 A control circuit shall comply with the requirements in 12.4, Separation of circuits.

24.2 The operation of an auxiliary control device in an appliance shall disconnect the element or elements that it controls from all ungrounded conductors of the supply circuit, unless there are no live parts exposed to unintentional contact when the auxiliary control device is open or unless it is apparent that such parts are live parts.

24.3 The operation of an auxiliary control device in an automatic toaster shall disconnect the element or elements that it controls from all conductors of the supply circuit in a cord-connected toaster and from all ungrounded conductors of the supply circuit for a permanently connected toaster if live parts are accessible to the extent that they are subject to unintentional contact when the appliance appears to be in a de-energized condition.

24.4 An auxiliary control is one that is intended primarily for time, temperature, or pressure regulation, and the like, under conditions of intended operation, and not for protection against overload or excessive temperature conditions resulting from abnormal operation.

24.5 A temperature-limiting control intended to reduce the risk of fire or electric shock shall be operative whenever the appliance is connected to its power supply. Except for the inherent thermal protector of a motor, the control of a permanently connected appliance that has exposed live parts shall disconnect the element or elements it controls from all ungrounded conductors of the supply circuit. The operation of such a control shall comply with the requirements in 24.2. A controlled contactor shall comply with the endurance requirement for a limiting control if it is part of the limiting-control circuit.

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

24.7 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 26, unless otherwise specified in this end product Standard; see 24.13.

24.8 Operating (regulating) controls shall be evaluated in accordance with the applicable component standard requirements specified in Electromechanical and Electronic Controls, Section 25, if applicable, and the parameters in Controls – End Product Test Parameters, Section 26, unless otherwise specified in this end product Standard; see 24.13.

24.9 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 – Part 1: General Requirements, UL 60730-1.

24.10 Protective (limiting) controls shall be evaluated in accordance with the applicable component standard requirements specified in Electromechanical and Electronic Controls, Section 25, and if applicable, the parameters in Controls – End Product Test Parameters, Section 26, unless otherwise specified in this end product Standard.

24.11 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 – Part 1: General Requirements, UL 60730-1, except the Controls Using Software requirements, Annex H.

24.12 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 – Part 1: General Requirements, UL 60730-1.

24.13 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.

25 Electromechanical and Electronic Controls

25.1 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 – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

25.2 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 Thermistor-Type Devices, UL 1434; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, with Annex J.

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

26 Controls – End Product Test Parameters

26.1 General

26.1.1 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 29.

26.1.2 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.

26.2 Auxiliary controls

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

26.2.2 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 Eelectronic Controls, Section 25, is considered to fulfill this requirement.

26.3 Operating controls (regulating controls)

26.3.1 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 – 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 26.1;

e) For the applicable Material Group, see Table 26.2; and

f) For the applicable Pollution Degree, see Table 26.3.

Table 26.1
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 26.2
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 26.3
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

26.3.2 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 – Part 1: General Requirements, UL 60730-1:

a) Control action Types 1 or 2;

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

c) For the applicable Overvoltage Category, see Table 26.1;

d) For the applicable Material Group, see Table 26.2; and

e) For the applicable Pollution Degree, see Table 26.3.

26.4 Protective controls (limiting controls)

26.4.1 An electronic control that performs a protective function shall comply with the applicable requirements in Automatic Controls and Control Circuits, Section 24, 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.

26.4.2 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 – 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 41;

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 41. 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 41; and

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

26.4.3 The test parameters and conditions used in the investigation of the circuit covered by 26.4.1, 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.

26.4.4 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.

26.5 Controls using a temperature sensing device

26.5.1 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.

27 Power Output Control Circuits

27.1 These requirements cover electronic controls that serve to manage the operation of the induction heating appliances in order to provide preprogrammed operating cycles that rely on timing, by scoring a series of events or by modifying the appliances' operation in a predetermined, repetitive fashion in order to comply with the normal test specified in Normal Temperature Test, Section 41.

27.2 An electronic control provided to comply with the normal operation test specified in Normal Temperature Test, Section 41, shall be subjected to a Failure Effect Mode Analysis (FEMA) as follows:

a) All active terminals of a multi-pin device shall be considered input, output, power supply, or ground;

b) Each electronic component in the control is to be included in this analysis;

c) Each component is to be identified as R1, C1, or an equivalent component identification;

d) The function of each component is to be described; and

e) The effects of open and short faults are to be evaluated for each component. The following are alternatives to shorting all combinations of terminals on multiple pin components, such as integrated circuits:

1) Short each pair of adjacent pins

2) Short each input pin to (referenced) ground

3) Short each output pin to (referenced) ground

4) Short each input pin to the power supply

5) Short each output pin to the power supply

27.3 For applicable electrical/electronic component fault modes, reference should be made to Table Table 27.1.

Table 27.1
Electrical/electronic component fault modes table

Component type	Short	Open[1]	Remarks
Fixed resistors			
Thin-film		X	Includes SMD type
Thick-film		X	Includes SMD type
Wire-wound (single layer) enamelled or suitably coated		X	
All other types	X	X	
Variable resistors (for example, potentiometer/trimmer)			
Wire-wound (single layer)		X	
All other types	X[2]	X	
Capacitors			
X and Y types according to the Safety Requirements for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14 and the Standard for Electromagnetic Interference Filters, UL 1283.		X	
All other types	X	X	
Inductors			
Wire-wound		X	
All other types	X	X	
Diodes			
All other types	X	X	
Semiconductor type devices like transistors			
All types (for example, bipolar; LF; RF; microwave; FET; thyristor; Diac; Triac; Uni junction)	X[2]	X	3
Integrated circuits			
All types not covered by Annex H, of the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.	X[4]	X	For IC outputs, note[3] applies
Optocouplers			
According to the Standard for Electrically Isolated Semiconductor Devices,UL 1557	X[5]	X	
Relays			
Coils		X	
Contacts	X	X	
Reed-relays	X	X	Contacts only
Transformers – According to the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1; the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers ,UL 5085-2; and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.		X	
All other types	X[2]	X	
Connections (jumper wire)		X	
Cable and wiring		X	

[1]Only opening of one pin at any one time.

[2] Short-circuit each pin in turn with every other pin; only two pins at a time.

Table 27.1 Continued on Next Page

Table 27.1 Continued

Component type	Short	Open[1]	Remarks
[3] For discrete or integrated thyristor type devices such as Triacs and SCRs, fault conditions shall include short circuit of any terminals with the third terminal open-circuited. The effect of any full wave type of component, such as a Triac going into a half-wave condition, either controlled or uncontrolled (thyristor or diode, respectively) shall be considered. [4] The short circuit of any two adjacent terminals and the short circuiting of: a) Each terminal to the IC-supply, when applicable at the IC; and b) Each terminal to the IC-ground, when applicable at the IC. [5] When optocouplers comply with the Standard for Electrically Isolated Semiconductor Devices, UL 1557, with an isolation voltage of 5 000 V, the shorting between the input and output pins is not considered.			

27.4 A circuit analysis made to assess the performance of individual components under a fault condition rather than actually creating the fault to determine its effect also meets the intent of the requirements. The effect resulting from the failure on the control and also on the end use product is to be stated. Results of the Failure Effect Mode Analysis (FEMA) indicating operation outside the intended parameters of the control's normal operation (for example, input power exceeding the appliance branch-circuit rating, component temperatures exceeding specified limits, or the inability to recognize required events) are to be subjected to the Abnormal Operation Test requirements, Section 55, with each fault applied independently (single-fault conditions).

27.5 The Failure Effect Mode Analysis (FMEA) is to be conducted as described in the Procedure for Preparing/Performing a Failure Mode, Effects and Criticality Analysis, Military Specification Number 1629.

27.6 The device or component shall be considered critical if a failure results in one of the following:

a) The risk of fire, electric shock and injury; or

b) The need of protective function in the control to prevent risk of fire, electric shock and injury.

28 Overheating Protection

28.1 The requirements in this Section are applicable to an air-type corn popper, bacon-broiler, broiler, toaster-oven, toaster oven/broiler and table stove, or an appliance provided with an enclosure complying with 6.6. These requirements are in addition to or modify the applicable requirements in Overcurrent and/or Over-Temperature Protection, Section 19; Automatic Controls and Control Circuits, Section 24; Electromechanical and Electronic Controls, Section 25; and Component Switches and Control Devices, Section 60.

28.2 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 55, are acceptable.

28.3 A limiting device shall be any one-time device or manual-reset thermostat, inaccessible to the user, (see 6.13 – 6.16) that performs its intended function when tested according to these requirements.

28.4 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 – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.

Exception: See 28.6.

28.5 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: See 28.6.

28.6 A thermostat or thermal cutoff need not comply with a specific requirement in the standard indicated in 28.4 and 28.5, respectfully, 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.

29 Spacings

29.1 Except as noted in 29.2 and 29.3, the spacings in an appliance shall be in accordance with Table 29.1 and Table 29.2.

29.2 The spacings specified in Table 29.1 and Table 29.2, do not apply to the inherent spacings of a component part of an appliance. Such spacings are judged under the requirements for the component in question.

Table 29.1
Minimum acceptable spacings at field-wiring terminals

Parts involved	Through air		Over the surface	
	inch	(mm)	inch	(mm)
Between live parts of opposite polarity; and between a live part and a dead metal part, other than the enclosure, which may be grounded	1/4	(6.4)	3/8	(9.5)
Between a live part and the enclosure	1/2	(12.7)	1/2	(12.7)
NOTES: 1) These spacings do not apply to connecting straps or busses extending away from wiring terminals. Such spacings are to be judged under Table 29.2. 2) Applies to the sum of the spacings involved where an isolated dead part is interposed.				

Table 29.2
Minimum acceptable spacings through air or over the surface at points other than field-wiring terminals or inside motors

Parts involved	Inches	(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	1/16	(1.6)
NOTES: 1) If an uninsulated live part is not rigidly supported, or if a movable dead metal part is in proximity to an uninsulated live part, the construction shall be such that at lest the minimum acceptable spacing of 1/16 inch (1.6 mm) is maintained under all operating conditions and under all conditions of handling. 2) 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.		

29.3 The spacings within a motor shall comply with the requirements in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

29.4 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 in an appliance. Within a thermostat, except at contacts, the spacings between uninsulated live parts on opposite sides of the contacts are to be not 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 is to be such that the spacings will be maintained permanently.

29.5 Except as noted in 29.6, 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 the 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.

29.6 Insulating material having a thickness less than specified in 29.5, may be used if it is equivalent in appropriate properties.

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

30 Spacings On Printed-Wiring Boards

30.1 As an alternative to the spacing requirements of , 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 44;

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 – 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.

30.2 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 26.1;

b) The applicable Material Group per Table 26.2;

c) The Pollution Degree shall be Pollution Degree 2, see Table 26.3; 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.

30.3 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.

31 Grounding

31.1 In an appliance intended for permanent connection to the power supply by a metal-enclosed wiring system (such as rigid metal conduit or armored cable), all exposed dead metal parts and all dead metal parts inside the enclosure that are exposed to contact during any servicing operation (including maintenance and repair) and that are likely to become energized shall be conductively connected to the point at which the cable armor, conduit, and the like, is attached to the appliance.

31.2 In an appliance intended for permanent connection to the power supply by means other than a metal-enclosed wiring system (such as non-metallic-sheathed cable):

a) An equipment-grounding terminal or lead shall be provided (see 10.1.2.13 and 10.1.2.14); and

b) All exposed dead metal parts and all dead metal parts inside the enclosure that are exposed to contact during any servicing operation (including maintenance and repair) that are likely to become energized shall be conductively connected to such terminal or lead.

31.3 On a cord-connected 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.

31.4 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 servicing and are likely to become energized, shall be conductively connected to the grounding conductor of the power-supply cord.

31.5 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 interlocked plug, receptacle, and connector that is not energized when the appliance grounding connection is made.

31.6 A cord-connected appliance that is intended for more than occasional outdoor use, a motor-driven spit, outdoor electric grill, food smoker, or similar device intended for outdoor use shall comply with either of the following:

a) The appliance shall be double insulated; or

b) The appliance shall have provision for grounding dead metal parts in the form of a grounding conductor in the cord and a grounding type of attachment plug, in accordance with 31.3 (see also 67.14).

Grounding shall not be used if the product is marked as being provided with double insulation.

31.7 A cord-connected two-wire appliance intended to operate at a nominal potential of 240 V (and similarly any other potential within the 220 – 250 V range) shall have provision for grounding in accordance with 31.3, unless the marked rating on the appliance is 120/240 V or unless the appliance is otherwise marked to indicate that it is to be connected only to a 120/240-V circuit with a grounded neutral.

31.8 The resistance shall not be more than 0.1 ohm between any point required to be grounded, as mentioned in 31.4, 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.

31.9 With reference to 31.8, 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 resistance (in ohms) computed by dividing the resultant 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.

32 Pressure Vessels and Parts Subject to Pressure

32.1 Except as noted in 32.2, a pressure vessel having an inside diameter of more than 6 inches (152 mm) and subject to a gauge pressure of more than 15 lbf/in^2 (103 kN/cm^2) shall be certified by the National Board of Boiler and Pressure-Vessel Inspectors and marked in accordance with the appropriate boiler and pressure vessel code symbol of the American Society of Mechanical Engineers (ASME) ("H", "M", "S", or "U") for a working pressure not less than the pressure determined by applying 32.3.

32.2 If a pressure vessel, because of its application, is not covered under the inspection procedures of the ASME code, it shall be designed and constructed so that it complies with the requirements in 32.3.

32.3 Except as noted in 32.4 and 32.5, a part that is subject to air or vapor pressure (including the vapor pressure in a vessel containing only a superheated fluid) during normal or abnormal operation shall withstand without bursting or leaking a pressure equal to the highest of the following that is applicable:

a) Five times the pressure corresponding to the maximum setting of a pressure-reducing valve provided as part of the assembly, but no more than five times the marked maximum supply pressure from an external source and no more than five times the pressure setting of a pressure-relief device provided as part of the assembly.

b) Five times the marked maximum supply pressure from an external source, except as provided in (a).

c) Five times the pressure setting of a pressure-relief device provided as part of the assembly.

d) Five times the maximum pressure that can be developed by an air compressor that is part of the assembly, unless the pressure is limited by a pressure-relief device in accordance with (a).

e) Five times the working pressure marked on the part.

32.4 A test need not be performed to determine whether a part complies with the requirement in 32.3, if study and analysis indicate that the strength of the part is adequate for the purpose as a result of its material and dimensions – for example, copper or steel pipe of standard size and provided with standard fittings might be considered to have adequate strength.

32.5 A pressure vessel bearing the ASME code inspection symbol ("H", "M", "S", or "U") is considered to comply with the requirement in 32.3, if the vessel is marked with a value of working pressure not less than that to which it is subject during normal or abnormal operation.

32.6 If a test is necessary to determine whether a part complies with the requirement in 32.3, two samples of the part are to be subjected to a hydrostatic-pressure test. Each sample is to be filled with water as to exclude air and is to be connected to a hydraulic pump. The pressure is to be raised gradually to the specified test value and is to be held at that value for 1 minute. The results are not acceptable if either sample bursts or leaks, except as indicated in 32.7.

32.7 Leakage at a gasket during the hydrostatic-pressure test is not unacceptable unless it occurs at a pressure 40 percent or less of the required test value.

32.8 A means for relieving pressure shall be provided for all parts in which pressure might be generated in the event of fire.

32.9 Pressure-relief devices (see 32.15), fusible plugs, soldered joints, nonmetallic tubing, or other pressure-relief means or the equivalent may be employed to comply with the requirements in 32.8.

32.10 There shall be no shut-off valve between the pressure-relief means and the parts that it is intended to protect.

32.11 A vessel having an inside diameter of more than 3 inches (76.2 mm) and subject to air or steam pressure generated or stored within the appliance shall be protected by a pressure-relief device.

32.12 The start-to-discharge pressure setting of the pressure-relief device shall not be higher than the working pressure marked on the vessel. The discharge rate of the device shall acceptably relieve the pressure.

32.13 A pressure-relief device shall comply with all four of the following:

a) Shall be connected as close as possible to the pressure vessel or parts of the system that it is intended to protect;

b) Shall be installed so that it is readily accessible for inspection and repair and cannot be readily rendered inoperative;

c) Shall have its discharge opening located and directed so that the risk of scalding is reduced to a minimum; and

d) Shall have its discharge opening located and directed so that operation of the device does not deposit moisture on bare live parts or on insulation or components affected detrimentally by moisture.

32.14 A pressure-relief device having an adjustable setting shall be judged on the basis of its maximum setting unless the adjusting means is sealed at a lower setting.

32.15 A pressure-relief device is considered to be a pressure-actuated valve or rupture member intended to relieve excessive pressures automatically.

32.16 Where a pressure relief device is required, the control responsible for limiting the pressure in the vessel shall be capable of performing under rated load for 100,000 cycles of operation and shall prevent the pressure from exceeding 90 percent of the relief device setting under any condition of normal operation.

33 Protection Against Personal Injury

33.1 Materials employed in the construction of an appliance to protect against personal injury shall be acceptable for the particular use. See 6.1 and 6.5.

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

Exception No. 2: This requirement does not apply to a part or portion of a part inaccessible to the probe illustrated in Figure 6.2.

33.3 Compliance with the requirement of 33.2, 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.

33.4 The release mechanism for detachable handles shall be:

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

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

33.5 A glass window or door that can be subject to contact by the user during use and routine maintenance of the appliance shall withstand the impact described in 50.1, or shall be constructed of glass that cracks or breaks as described in 50.1.

33.6 The handles of a slow cooker shall comply with the Handle Impact Test for Slow Cookers, Section 51, and the Handle Strength Test for Slow Cookers, Section 58.

Exception: Ceramic, metallic, or glass integral handles of the removable cooking vessel of a slow cooker are not required to comply with Sections 51 and 58.

33.7 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 32 mm (1.25 in) maximum with a diameter greater than its height.

Exception: Not applicable to an appliance intended only to be mounted above a countertop.

33.8 The racks of a toaster oven or toaster oven/broiler shall comply with the Oven Rack Loading Test, Section 54A.

34 Ground-Fault, Arc-Fault, and Leakage Current Detectors/Interrupters

34.1 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."

34.2 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.

34.3 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.

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

34.5 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.

34.6 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.

34.7 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.

34.8 An arc-fault circuit-interrupter AFCI or leakage-current detector-interrupter LCDI provided as part of an appliance intended for outdoor use shall comply with the applicable outdoor use requirements of this end product Standard.

35 Surge Protective Device

35. 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

36 General

36.1 The performance of an appliance shall be investigated by subjecting the required number of samples to all the applicable tests specified in Sections 37 – 63. 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.

37 Power Input Test

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

37.2 To determine whether an appliance complies with the requirement in 37.1, the power input is to be measured with the appliance at normal operating temperature under full-load conditions (if required for normal operation) and while connected to a supply circuit adjusted to be the highest of the following:

a) The marked voltage rating; or

b) The highest voltage of the applicable range of voltages specified in 66.1, if the marked voltage is within one of the voltage ranges indicated in 66.1.

If an appliance employs a nonmetallic element (such as carbon), the power input is to be determined for an unused element.

38 Leakage Current Tests

38.1 The leakage current of a cord-connected appliance rated for a nominal 120-V or 240-V supply when tested in accordance with 38.3 – 38.8, 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 38.3 – 38.8, 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.

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

38.3 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 6.1 – 6.16. 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.

38.4 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 long enough to affect the temperature of the appliance.

38.5 A heated surface of insulating material is to be investigated concerning the leakage current available from the use of metal utensils.

38.6 The measurement circuit for leakage current is to be shown in Figure 38.1. The ideal measurement instrument is defined in (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 instrument. The meter used need not have all the attributes of the ideal instrument.

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

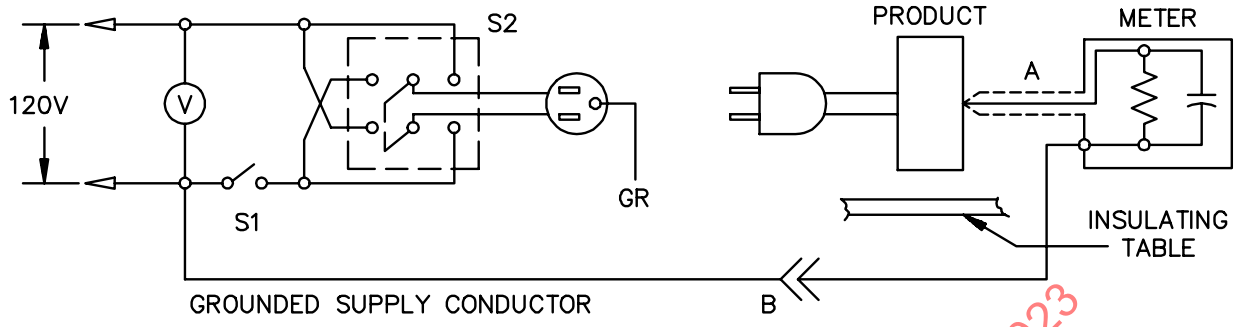
b) The meter is to indicate 1.11 times the average of the full-wave rectified composite wave-form of voltage across the resistor or current through the resistor.

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 the impedance of 1500 ohm resistor shunted by a 0.15 µF capacitor to 1500 ohms. At an indication of 0.5 or 0.75 mA, the measurement is to have an error of not more than 5 percent at 60 Hz.

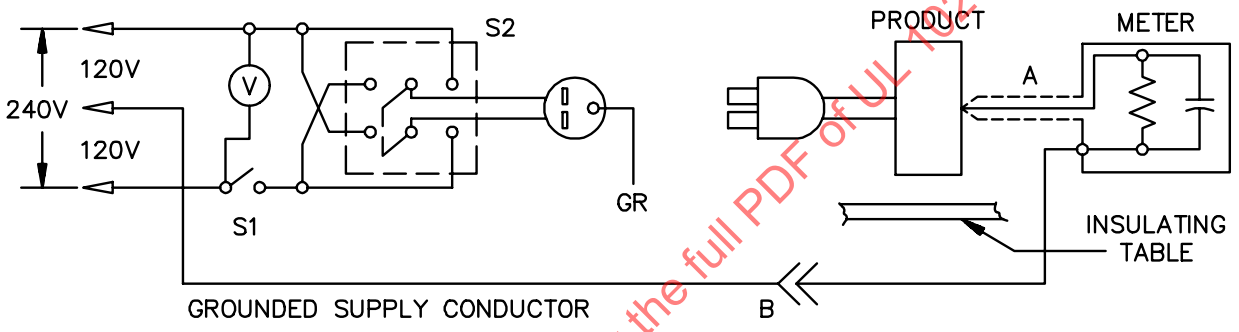
d) Unless the meter is being used to measure leakage from one part of an appliance to another, the meter is to be connected between the accessible parts and the grounded supply conductor.

Figure 38.1

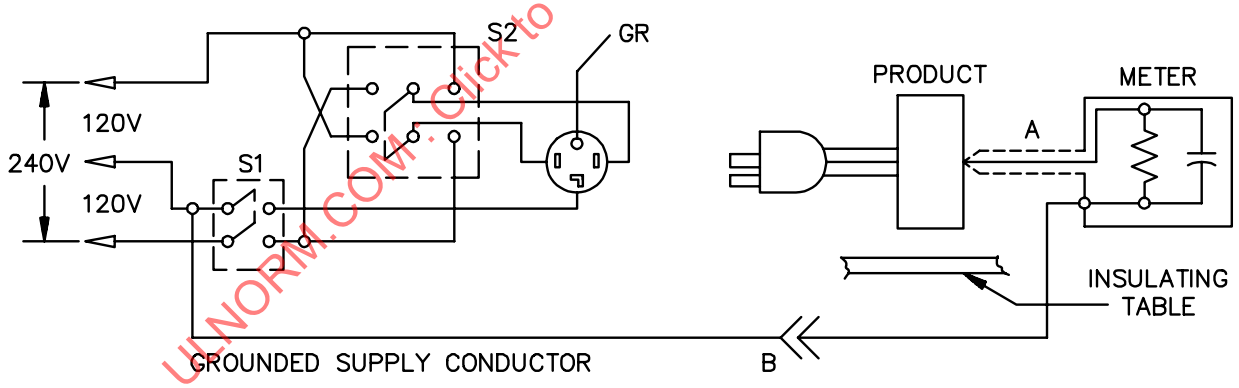
Leakage-current measurement circuit



Appliance intended for connection to a 120–V power supply, as illustrated above.



2–wire appliance intended for connection to a 3–wire, grounded neutral power supply, as illustrated above.



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

NOTES –

A – Probe with shielded lead.

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

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38.7 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 voltages are to be 120 to 240 V. The test sequence, with reference to the measuring circuit (Figure 38.1), 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.

38.8 Normally a sample will be carried through the complete leakage current test program as covered by 38.7, without interruption for other tests. With the concurrence of those concerned, the leakage current tests may be interrupted for the purpose of conducting other nondestructive tests.

39 Operational Tests

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

39.2 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.

40 Calibration of Probe-Type Temperature Controls Tests

40.1 Ovens

40.1.1 The maximum temperature in the center of an oven shall not be higher than 300°C (572°F) either before or after a probe-type control is dropped five times from a height of 3 feet (0.91 m) onto a hardwood surface.

40.2 Other appliances

40.2.1 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 40.2.2. The average of the maximum and minimum temperatures shall not be higher than 260°C (500°F) either before or after the dropping.

40.2.2 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 feet (0.91 m) onto a hardwood surface, following which the control is to be recalibrated.

40.3 All appliances

40.3.1 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.

41 Normal Temperature Test

41.1 General

41.1.1 An appliance, when tested under the conditions described in Section 41, 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 that damages any materials employed in the appliance;

b) At any time during the test – other than as indicated in 41.1.2 and 41.1.3 – temperature rises at specific points shall not be greater than indicated in Table 41.1; and

c) The appliance shall comply with the requirement in 6.1.

Table 41.1
Maximum acceptable temperature rises

Materials and component parts	°C	(°F)
1. Any point within a terminal box or wiring compartment of a permanently connected appliance in which field-installed conductors are to be connected (including such conductors themselves) unless the appliance is marked in accordance with 67.12	35	(63)
2. Any point on a surface adjacent to a permanently connected appliance or wall-mounted or under-cabinet mounted cord-connected appliance, including the surface on which the appliance is mounted, and specified points on test surfaces and enclosures at designated clearances from the appliance	65	(117)
3. Any point on a surface of a wall-mounted or under-cabinet cord connected appliance exposed to casual contact except for surfaces that are intended for contact during normal operation of the appliance	e	e
4. Fuses	65	(117)
5. Fiber used as electrical insulation or as cord bushing	65	(117)
6. Wood or other combustible material which is part of a heating appliance	65	(117)
7. Cotton or rayon braiding of flexible cord	65	(117)
8. Class 105 insulation systems on winding of relays or solenoids and the like:		

Table 41.1 Continued on Next Page

Table 41.1 Continued

Materials and component parts	°C	(°F)
Thermocouple method	65	(117)
Resistance method	85	(153)
9. Class A insulation systems on coil windings of d-c and universal motors[a]:		
a) In open motors:		
Thermocouple method	65	(117)
Resistance method	75	(135)
b) In totally enclosed motors:		
Thermocouple method	70	(126)
Resistance method	80	(144)
10. Class A insulation systems on coil windings of a-c motors (not including universal motors) and on vibrator coils – thermocouple or resistance method[a]		
a) In open motors and on vibrator coils	75	(135)
b) In totally enclosed motors	80	(144)
11. Class 130 insulation systems on windings of relays, solenoids, or the like:		
Thermocouple method[a]	85	(153)
Resistance method	105	(189)
12. Class B insulation systems on coil windings of d-c and universal motors[a]:		
a) In open motors:		
Thermocouple method	85	(153)
Resistance method	95	(171)
b) In totally enclosed motors:		
Thermocouple method	90	(162)
Resistance method	100	(180)
13. Class B insulation systems on coil winding of a-c motors (not including universal motors) and on vibrator coils – thermocouple or resistance method[a]		
a) In open motors and on vibrator coils	95	(171)
b) In totally enclosed motors	100	(180)
14. Phenolic composition used as electrical insulation or where deterioration would result in a risk of fire, electric shock, or injury to persons[b]	125	(225)
15. Points on surface supporting a cord-connected appliance other than wall-mounted or under-cabinet	100	(180)
16. Points on adjacent surfaces of test corner for counter-top appliances	100	(180)
17. Flatiron or appliance plug face	175	(315)
18. Insulated wire or cord	25°C less than its temperature rating[c]	(77°F less than its temperature rating[c])
19. Sealing compound	d	d
a) Copper tinned or bare strands:		
1) Less than 0.015 inch (0.38 mm) in diameter	125	(225)
2) 0.015 inch (0.38 mm) diameter and larger	175	(315)
b) Nickel, gold or silver platings, or combinations of those platings over copper conductors	225	(405)

Table 41.1 Continued on Next Page

Table 41.1 Continued

Materials and component parts	°C	(°F)
20. Termination of copper conductor and pressure terminal connector without being nickel-coated or otherwise acceptably protected	125	(225)

[a] See 41.1.12 and 41.1.13.

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

[c] 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 appropriate for the temperature and the type of insulation involved.

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

[e] Maximum temperature shall not exceed the temperature specified in Table 42.1, unless appliance is marked "CAUTION – Hot Surface" and temperature rise does not exceed 100°C (180°F). Such marking shall be in letters not less than 3/32 inch (2.4 mm) high, see 67.22.

41.1.2 Initial temperature transients may be in excess of the temperature limits specified in Table 41.1 and 41.1.3, if the duration and extent of the excursion do not result in risk of fire or electric shock.

41.1.3 Temperatures are to be measured during preheat modes. Temperature rises not exceeding those specified in Table 41.1, by more than 20 percent are acceptable.

41.1.4 All values in Table 41.1, 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.

41.1.5 During intended operation, the temperature of the fat, oil, or grease in the drip pan or equivalent part of a grill-type broiler shall be less than the flash point of the fat.

41.1.6 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.

41.1.7 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. Usually the appliance is to be operated dry and for a period of 240 hours.

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

41.1.9 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, it is standard practice to employ thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer-type instrument, and such equipment is to be used whenever referee temperature measurements by thermocouples are necessary. The thermocouple wire is to conform with the requirements for Special Tolerances thermocouples as listed 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.

41.1.9.1 If the magnetic field of an induction heating appliance unduly influences the results, the temperature rises can be determined using non-iron type thermocouple or using platinum resistances with twisted connecting wires or any equivalent means.

41.1.10 For tests that are to be continued until constant temperatures are attained, thermal equilibrium is 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.

41.1.11 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 will 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.

41.1.12 Usually, the temperature of a coil or winding is to be measured by means of thermocouples mounted on the outside of the coil wrap. If the coil is inaccessible for mounting thermocouples (for example, a coil immersed in sealing compound) or if the coil wrap includes thermal insulation, or more than 1/32 inch (0.8 mm) of cotton, paper, rayon, or similar insulation, the change-of-resistance method is to be used. For the thermocouple-measured temperature of a coil of an alternating-current motor (other than a universal motor) the thermocouple is to be mounted on the integrally applied insulation of the conductor.

41.1.13 At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature rise measured by means of a thermocouple may be higher – by the amount specified in Table 41.2 – than the maximum indicated in Table 41.1, provided that the temperature rise measured by the change-of-resistance method does not exceed the values indicated in Table 41.1. If the coil wrap does not exceed its temperature limitation by radiation from an external source, the temperature of the coil may be measured by means of a thermocouple on the integral insulation of the coil conductors.

Table 41.2
Additional thermocouple temperature rise

Item in Table 41.1	Additional thermocouple rise	
	°C	(°F)
Item 8	15	(27)
Item 10(a)	5	(9)
Item 12(a)	20	(36)
Item 13(a)	10	(18)

41.1.14 To determine whether an appliance complies with the requirements in 41.1.1, the appliance is to be operated continuously until constant temperatures have been reached. The test voltage is to be the highest of the following:

a) The marked voltage rating; or

b) The highest voltage of the applicable range of voltages specified in 66.1, if the marked voltage is within one of the voltage ranges indicated in 66.1.

41.1.15 Unless a particular voltage or other test condition is specified in 41.2.1.1 – 41.2.7.1, the test voltage specified in 41.1.14, 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.

41.1.16 If an appliance employs a motor in addition to a heating element, the voltage applied to an integrally connected motor is to be the test voltage as specified in 41.1.14. A motor supplied from a separate circuit is to be connected to a test voltage derived from its marked rated voltage in accordance with 41.1.14.

41.1.17 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 intended 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, including building wiring which may be located adjacent to or behind a permanently installed appliance.

41.1.18 A counter-type 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 no less than 2 feet (0.61 m) beyond the physical limits of the appliance. The vertical walls are to meet at a right angle.

Exception No. 1: Front- or side-loaded appliances (such as a toaster-oven, broiler, and convection oven)and other appliances (such as a table stove, food warmer, and food tray), which by virtue of their size, usual loading and unloading procedures, or intended usage are not likely to be moved from a counter resting location prior or during use, are to be located with the back of the appliance placed directly against one wall of the corner, and with 4 inches (102 mm) maintained from the side of the appliance to the other corner wall.

Exception No. 2: An appliance intended for outdoor use only is not required to be tested in a test corner.

41.1.19 A cord-connected wall or under-cabinet mounted appliance is to be mounted on one wall or cabinet bottom of a test corner consisting of dull black-painted fir plywood not less than 3/8 inch (9.5 mm) thick, having such a width and height that the walls extend not less than 2 feet (0.61 m) beyond the physical limits of the appliance. The vertical walls are to meet at a right angle. Unless marked as described in 67.13, the appliance is to be placed as close to the corner wall as the construction will permit, and an under-cabinet appliance is to be in contact with the rear wall while a wall-mounted appliance is to be in contact with either the cabinet bottom or the counter, whichever results in the highest temperature. The cabinet bottom is to be 12 inches (305 mm) deep, located 16 inches (406 mm) above the counter top. The surface beneath the unit is to be softwood covered with a double layer of white tissue paper.

41.1.20 Thermocouples are to be mounted on wood surfaces using the method illustrated in Figure 41.1 or the equivalent. Starting in the corner, thermocouples are to be placed every 3 inches (76 mm) on each surface (Figure Figure 41.2) so that a minimum area of 18 inches by 18 inches (457 mm by 457 mm) is covered by the thermocouples on each surface.

Figure 41.1

Method of mounting thermocouple

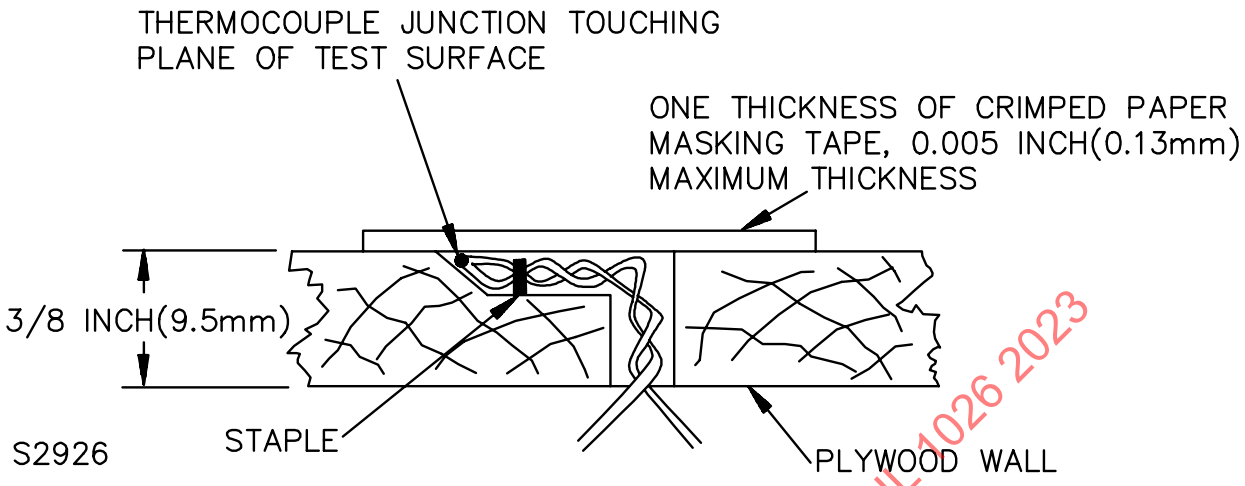
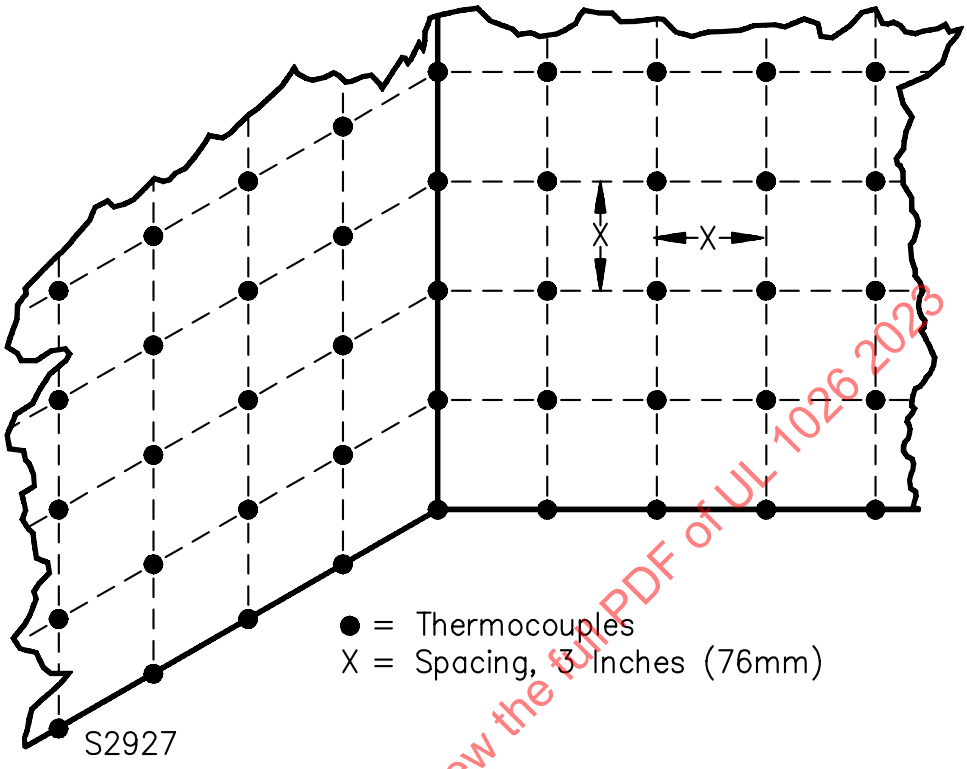


Figure 41.2

Thermocouple spacings



41.1.21 An appliance intended to be permanently connected to the power supply is to be supported in the intended manner on black-painted wood not less than 3/8 inch (9.5 mm) thick and is to be located in a corner (vertical walls meeting at a right angle) formed by two black-painted, vertical sheets of 3/8 inch (9.5 mm) plywood having such width and height that they extend not less than 2 feet (0.61 m) beyond the physical limits of the appliance. The appliance is to be located as close to both walls of the corner as its construction permits, and it is to be placed relative to the walls so that maximum heating of the walls occurs, except that it may be spaced away from the walls to preclude the wall temperatures from rising more than 65°C (117°F) if the appliance is marked as described in 67.13. For wall-mounted or under-cabinet mounted appliances intended to be permanently connected to the power supply, mounting is to be as specified in 41.1.19.

41.1.22 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.

41.1.23 An automatic temperature-regulating or -limiting control or other protective device is to be shunted out of the circuit, unless the control has been shown, in accordance with Table 60.1, to be rugged, reliable, and unlikely to be defeated by the user. The control is considered unlikely to be defeated if tools are required to gain access to the control, or a positive stop is incorporated in the control.

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

41.1.25 If the construction of an appliance is such that cooking or heating of a liquid is a determining factor in the temperature attained (such as in a slow cooker or food warmer), the intended duty of an appliance is to be taken into consideration. Normal operating conditions cannot be obtained however, if certain types of appliances are operated continuously and in a dry condition. Accordingly, in determining

whether or not an appliance complies with the requirements in 41.1.1, 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 stabilized.

41.1.26 An appliance that may either be opened or closed in actual service is to be tested both opened and closed to determine which condition produces the higher operating temperature. In the case of an open-front tabletop broiler or the like where some cooking operation may be performed without a tray in the broiler compartment, temperatures are to be measured on the horizontal supporting surface in front of the open face of the appliance.

41.1.27 External thermal insulation, such as woven glass fiber or mineral wool, is to be removed before a heating appliance is installed in the test enclosure unless the material is bonded or permanently attached to the appliance. Rubber or other material similarly subjected to deterioration is to be removed from feet or other supports if the removal of the material is likely to result in higher temperatures being attained on the appliance.

41.1.28 Wherever cheesecloth is mentioned in connection with either a temperature test or an abnormal test, the cloth is to be bleached cheese-cloth, running 14 – 15 yd^2/lb (approximately 28 – 30 m^2/kg), and having what is known to the trade as a "count of 32 × 28" – that is, for any inch square, 32 threads in one direction and 28 threads in the other direction (for any centimeter square 13 threads in one direction and 11 threads in the other direction).

41.1.29 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 69.8.

41.1.30 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 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.

41.2 Specific test condition

41.2.1 General

41.2.1.1 For most of the common types of appliances, standardized conditions for the temperature tests are given in 41.2.2.1 – 41.2.8.1.

41.2.1.2 In the case of a multi-functional appliance, such as a toaster oven/broiler, the appropriate tests for each function are to be conducted as specified in 41.2.2.1 – 41.2.7.1.

41.2.2 Electrically-equipped barbecue units and grill-type broilers

41.2.2.1 In the case of grill-type broiler, barbecue unit, or the like that is intended to burn solid fuel (see 55.2.4.2 and 67.8) the heat source is to be a fire of charcoal briquettes as follows:

a) In a circular fire box, a conical pile of fuel having a diameter 3/4 of that of the box, and a height 3/4 of that of the sides of the box, but not less than three briquettes high; or

b) In a rectangular fire box, a pyramidal pile of fuel having respective width and length 3/4 of those of the box, and a height 3/4 that of the sides of the box, but not less than three briquettes high.

41.2.3 Broilers, ovens, and grills

41.2.3.1 A convection oven, broiler, grill, or a broiler/oven is to be preheated in accordance with 41.1.29. The cooking tray or rack is to be loaded to 75 – 80 percent of its capacity with hamburgers. A total of 3 loads of hamburgers are to be cooked until well done. A 10-second interval per hamburger is to be allowed for changing loads. On an appliance that broils only on one side, a 5-second interval per hamburger is to be allowed for turning the hamburgers at the middle of each cycle. If the appliance is marked with a temperature setting for hamburgers, the specified temperature is to be used for the test. Otherwise, the maximum temperature setting is to be used. Temperatures are to be measured continuously during each cooking cycle. A maximum of 30 seconds is to be allowed between hamburger loads for emptying a grease tray.

41.2.3.2 An oven, convection oven, or a broiler/oven is to be preheated in accordance with 41.1.29, and then operated while baking potatoes. The potatoes are to occupy 75 – 80 percent of the bake tray. The temperature control setting is to be adjusted to maintain an oven chamber temperature of 204°C (400°F) or the temperature setting marked in a readily visible location on the appliance, but not less than 177°C (350°F) in any case. The potatoes are to be standard baking potatoes each weighing between 0.375 – 0.625 lb (0.17 – 0.283 kg). Temperatures are to be measured continuously during the test. The test is to be terminated when the internal center temperature of a centrally located potato is 99°C (210°F).

41.2.4 Table stoves

41.2.4.1 The appliance is to be operated continuously with each heating unit covered with a shallow pan of water. The diameter of the bottom plane surface of a pan is to be equal to the outside diameter of the active part of the heating element with a plus tolerance on 1 inch (25.4 mm).

41.2.5 Toaster

41.2.5.1 A toaster, toaster oven, or toaster oven/broiler is to be operated first toasting a total of six slices of bread with one slice of bread per cycle and then toasting a total of 24 slices of bread while loaded to its maximum capacity. Between the two sets, a sufficient cool-down period is to be allowed for the appliance to return to its ambient temperature. For each of the two tests, the bread is to be toasted to a medium brown color as rapidly as the toaster will operate. The bread is to be commercially available white bread weighing approximately 25 grams. A medium brown color is to be determined by use of the toast color chart in Appendix A.

41.2.6 Warming trays and food warmers

41.2.6.1 Warming trays (receive only vessels on the heated surface) and food warmers (receive food directly on the heated surface) are to be operated continuously with the thermostat set at the maximum-

heat position and with the surface empty. If the thermostat cycles, the test is to be repeated with a vessel containing water (minimum depth: 1 inch or 25 mm) placed on the heating surface over the thermostat. The vessel normally consists of a 6-inch-diameter (152-mm) shallow pan.

41.2.7 Rotisseries

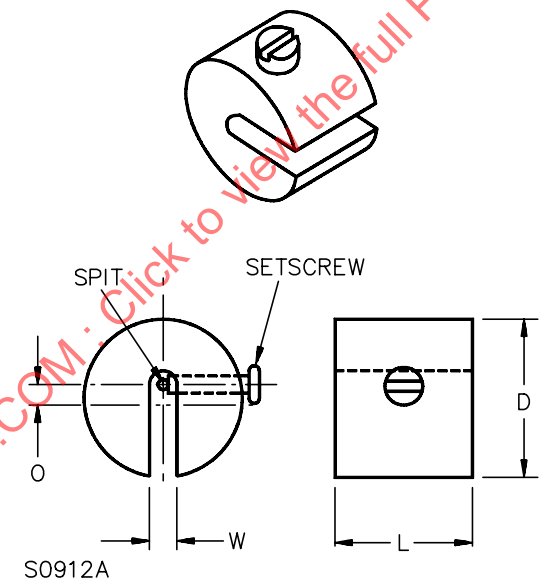
41.2.7.1 A rotisserie is to be operated continuously until thermal equilibrium is obtained. During the test, the manufacturer's maximum recommended load, or if not specified, a 10 lb (4.5 kg) steel weight as shown in Figure 41.3, is to be employed. In the case of multiple spits, each spit is to be loaded with the manufacturer's maximum recommended load or a total of 10 lb (4.5 kg) distributed equally among the spits.

41.2.8 Automatic bread makers

41.2.8.1 An automatic bread maker is to be operated for two complete cycles making the maximum size loaf of white bread in accordance with the manufacturers instructions. The second cycle is to begin immediately after completion of the first cycle.

Figure 41.3

Load for rotisseries



Dimension	Inches	(mm)
O	7/32	(5.6)
W	3/4	(19)
L	3-3/8[a]	(85.7[a])
D	4	(102)

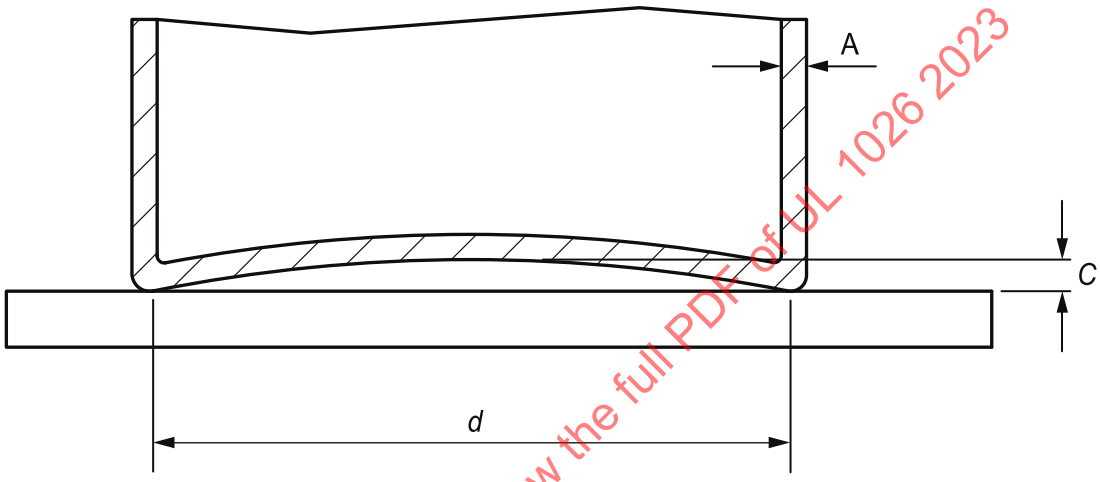
[a] Length approximate, length varied to obtain weight specified.

41.2.9 Induction Table Stove

41.2.9.1 Induction hotplates are operated for 30 minutes with vessels, as specified in Figure 41.4, containing pure cold pressed peanut oil. Controls are adjusted to their highest setting until the oil temperature reaches 180°C ±4°C (356°F ±39.2°F) and are then adjusted so that this temperature is maintained. The oil temperature is measured 1/2 inch (13 mm) above the center of the bottom of the vessel.

Figure 41.4

Vessel for testing induction table stove



Key:

A – Base and wall thickness, 2 mm ± 0.5 mm

C – Maximum concavity

d – Diameter of the flat area of the base

The vessel is made of low carbon steel having a maximum carbon content of 0,08 %. It is cylindrical without metallic handles or protrusions. The diameter of the flat area of the base of the vessel shall be at least the diameter of the cooking zone. The base of the vessel shall not be convex. The concavity of the base of the vessel shall not exceed 0.006 d.

41.2.10 Rice Cooker

41.2.10.1 A rice cooker is to be filled the maximum capacity of rice and water in accordance with the manufacturers instructions and is to be operated for two complete cycles of rice cooking. The cycle is considered as having ended when the thermostat automatically switches to the low or off position. The second cycle is to begin immediately after completion of the first cycle as the control allows. The temperatures are to be measured throughout the two cycles, and also when the rice cooker has subsequently operated on low heat until temperatures having become stabilized.

42 Top-Front Edge Temperatures – Convection Ovens Tests

42.1 When tested under the conditions described in this Section, the temperatures of an external top-front edge of a convection oven with a top-mounted manual control panel shall not exceed the maximum acceptable temperatures specified in Table 42.1.

Exception: This requirement does not apply to an oven that is marked in accordance with 67.21.

42.2 With reference to 42.1, a top-front edge is considered to be a locus of points on the top-front horizontal plane, located 7/64-inch (2.8 mm) to the rear of and parallel to the front vertical enclosure panel. A top-mounted manual control panel is considered to be one that is mounted 6-inches (152 mm) or more horizontally behind the top-front edge of the appliance.

42.3 All values for temperatures specified in Table 42.1, are based on a 25°C (77°F) ambient (air) temperature within the range of 20 – 30°C (68 – 86°F).

Table 42.1
Maximum temperature limits

	°C	(°F)
Bare or painted metal	67	(152)
Porcelain enamel	71	(160)
Glass	78	(172)
Plastic[a]	83	(182)

[a] Includes plastic with a metal plating not more than 0.005 inch (0.127 mm) thick; and metal with a plastic or vinyl covering not less than 0.005 inch (0.127 mm) thick.

42.4 For the test described in 42.5 – 42.10, if the ambient temperature is other than 25°C (77°F), the temperatures measured are to be corrected to this ambient – that is, the temperatures are to be decreased or increased, as appropriate, 1 degree for each degree the ambient is greater than or less than 25°C (77°F).

42.5 A convection oven is to be completely assembled for the test – all handles, knobs, guards, and the like are to be mounted in place. A shelf, a rack, or the like may be removed if it interferes with the placement of the thermocouple used to measure oven temperature.

42.6 With reference to the requirement in 42.1, corrugated, dimpled, and similarly finished edges are to be tested. Edges are to be clean when temperatures are measured.

42.7 Temperatures are to be measured immediately prior to or following oven thermostat cycling – opening of thermostat – after the convection oven has been operating for 1 hour with the temperature control maintaining an average oven temperature of 204 ±3°C (400 ±5°F) and constant surface temperatures have been attained.

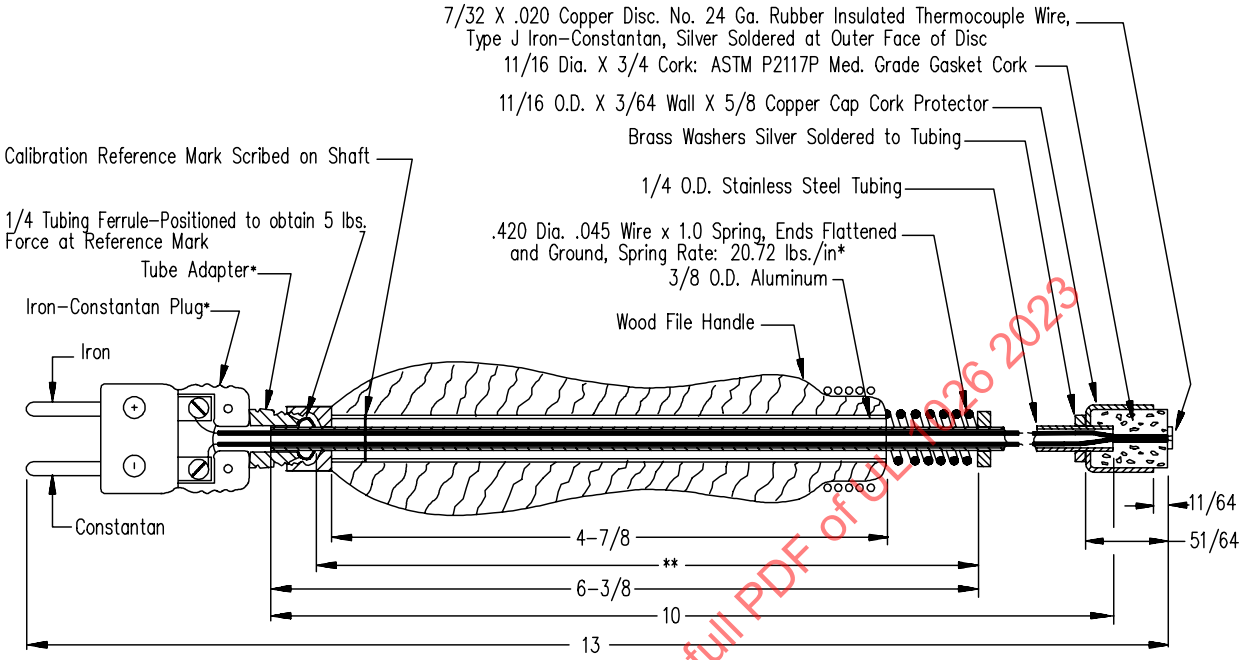
42.8 Convection-oven temperatures are to be measured with a single unshielded thermocouple located in the geometric center of the oven cavity.

42.9 Top-front temperatures are to be measured using the probe illustrated in Figure 42.1. For each measurement, the probe is to be at the ambient temperature, and then is to be preheated for 15 seconds to approximately the temperature of the edge under consideration. Preheating consists of applying the probe with a 5 lbf (22 N) force for 15 seconds to a similarly heated edge located approximately 1 inch (25.4 mm) from the edge to be tested. The probe is then to be vertically applied to the edge under consideration with a 5 lbf for 10 seconds. The probe is to be moved from the preheat position to the edge as quickly as possible, and is to be applied so that the probe disc is tangent to the front edge with the axis of the probe perpendicular to the horizontal enclosure panel of the convection oven.

42.10 A top-front edge temperature is considered to be constant when three successful readings taken at not less than 5-minute intervals indicate no change.

Figure 42.1

Temperature measuring and accessibility probe



43 Tests for Insulation Resistance and Leakage Current as a Result of Moisture

43.1 An appliance employing insulation material likely to be affected adversely by moisture under condition of intended 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:

a) A cord-connected appliance rated for a nominal 120- or 240-V supply shall comply with the requirement in 38.1, in a repeat leakage current test, except that the test shall be discontinued when leakage current stabilizes.

b) An appliance other than mentioned in (a) shall have an insulation resistance of not less than 50,000 ohms between live parts and interconnected dead metal parts.

43.2 The insulation resistance is to be measured:

a) By a magneto megohmmeter that has an open circuit output of 500 V;

b) By a voltmeter having an internal resistance of at least 30,000 ohms and using a 250-V d-c circuit; or

c) By equivalent equipment.

43.3 If glass-fiber sleeving is used as electrical insulation in a rope heater assembly, a previously untested appliance shall 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 that it 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 38.1, in a repeat leakage 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 in 44.1.

43.4 An appliance that, due to its construction and intended use, can be expected to be used outdoors (for example, an outdoor electric grill, motor-operated spit, and the like) shall be subjected to any of the applicable tests, as required by 43.5.

a) A cord connected appliance rated for a nominal 120- or 240-V supply shall comply with the requirement in 38.1, in a repeat leakage current test, except that the test shall be discontinued when leakage current stabilizes.

b) An appliance other than those mentioned in (a) shall have an insulation resistance of not less than 50,000 ohms.

c) An appliance shall also be capable of withstanding without breakdown for a period of 1 minute the application of a 60 Hz essentially sinusoidal potential between live parts and interconnected dead metal parts. The dielectric test potential shall be 1000 V.

43.5 One sample of an appliance that is expected to be used outdoors is to be mounted as in actual service (the appliance is to be mounted in any shield or other shelter that the manufacturer provides for use with the appliance). While mounted and without being energized, the appliance is to be subjected for 4 hours to a water spray applied at an angle 45 degrees from the vertical and adjusted to be equivalent to a beating rain. After this conditioning and while still mounted, the appliance is to be tested first for leakage current or for insulation resistance and then dielectric withstand as indicated in 43.4.

43.6 In the case of a warming tray and an induction table stove, a solution of 1/2 g of calcium sulphate ($CaSO_4 \cdot 2H_20$) per liter of distilled water, in sufficient quantity to cover the appliance surface to a depth of 5 mm, is to be sponged over the serving surface. The sponging operation consists of using the volume of

water described above in a simulated cleaning operation with the water being allowed to drain from the edges. At the conclusion of this test, the leakage current or insulation-resistance and the dielectric-withstand tests described in 43.4, are to be conducted. The leakage current is not to exceed 0.5 mA.

43.7 In the case of food warmers, the volume of hard water solution described in 43.6, is to be poured on the surface of the appliance and allowed to remain for a period of 1 hour. Without removing the solution, the tests described in 43.4, are to be conducted.

43.8 Except as noted in 43.9, an appliance (such as a food warmer) that is likely to be immersed in water for cleaning shall show a leakage current of not more than 0.5 mA and shall be capable of withstanding a potential of 1000 V when tested in accordance with 43.9 – 43.12. 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.

43.9 An appliance marked to indicate that it is not intended for immersion need not comply with the requirements in 43.8. See 67.18.

43.10 Three samples of the appliance are to be heated as described in 43.12, and after disconnection from the supply circuit, 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 67.18), 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 as indicated in 43.4.

43.11 The entire procedure of immersion and leakage current measurement is to be repeated four times, and immediately following, each sample is to be subjected to a 1000-V dielectric voltage-withstand test as described in 44.1. The three samples are to be used for aging tests and are required to comply with the requirements in 41.1.7 – 41.1.9. 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 (see 43.8). See Table 43.1.

Table 43.1
Immersion tests

	All appliances likely to be immersed		
	Sample No. 1	**Sample No. 2**	**Sample No. 3**
First 5 cycles	Conditioning for Tests Dry initially and throughout conditioning Immerse 1 hour Dry with cloth Leakage-current test		
After 5th cycle	High-potential test Operate 240 hours Cool to room temperature Reheat as for normal-temperature test Immerse for 1 hour Leakage-current test High-potential test		
NOTE – If there is an air cavity housing electrical components in the appliance, disassemble and examine for water.			

43.12 The 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.

43.13 A food-warming tray or food warmer provided with a seal is to be energized and maintained at its maximum temperature for 2-1/2 hours. Then it is to be cooled to ambient temperature and re-energized. Operation in this manner is to continue until 1000 hours of "on" time has accrued. The test described in 43.6 or 43.7, is then to be repeated.

44 Dielectric Voltage-Withstand Test

44.1 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 (rms) shall be 1000 V.

44.2 With respect to 44.1, 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.

44.3 With respect to 44.1 and 44.2, a part is considered to be accessible if it can be contacted by the probe illustrated in Figure 6.2, when applied in all possible articulated positions, with and without the parts referenced in 6.16, in place.

44.4 To determine whether an appliance complies with the requirements in 44.1, the test potential is to be applied as described in 44.6, by means of test equipment having the characteristics outlined in 44.5.

44.5 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 requirement 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 No. 1: The sensitivity of the test equipment may be reduced, a lower value of calibrating resistance may be used, when testing an appliance intended to be permanently wired.

Exception No. 2: The sensitivity of the test equipment may be increased, a higher value of calibrating resistance may be used, if agreeable to those concerned.

44.6 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, to the specified test potential in approximately 5 seconds, and then is to be maintained at the test potential for one minute. Manual control of the rate of rise may be used.

44.7 In the case of an appliance in which the electric wiring passes through a hinged member or spring, the cover is to be raised and lowered three or more times while the test potential is being applied in order to determine whether an indication of unacceptable performance may result from damaged insulation on the conductors while the cover is in other than the closed position.

45 Mechanical Endurance Test

45.1 If the intended operation of an 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 45.2. If the cleaning of an appliance, such as a range element on a table stove, causes movement of the internal wiring, the movable part shall be capable of operating successfully for 1000 cycles unenergized in the intended manner indicated in 45.2. There shall be no electrical or mechanical malfunction and, after the test, the appliance shall comply with the requirements for dielectric voltage-withstand in 44.1 – 44.7.

45.2 In a test to determine whether an appliance complies with the requirements in 45.1, any 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 operated so that it reaches the actual limits of travel in both directions, each cycle.

46 Broken Element Test

46.1 An open-wire heating element in an appliance shall be constructed and supported so that if the wiring is cut at any point there shall be no reduction of electrical spacings below the limits specified in this standard. Except for an automatic toaster, 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.

46.2 To determine compliance with 46.1:

a) The appliance is first to have been operated until fully heated as in the Power Input or 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.

47 Push-Back Relief Test

47.1 To determine compliance with 10.2.2.3, a product shall be tested in accordance with 47.2, 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.

47.2 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 10.2.2.3.

48 Overflow Test

48.1 General

48.1.1 If an appliance incorporates a reservoir or liquid-storage chamber that is likely to be over-filled in intended service, liquid overflowing from the reservoir or chamber shall not wet uninsulated live parts or film-coated wires, and shall not wet electrical insulation that is likely to be adversely affected by the liquid used in the reservoir or chamber.

48.1.2 To determine whether an appliance complies with the requirement in 48.1.1, it is to be tested as follows: water is to be used for the test, and is to be poured into the reservoir through an orifice 3/8 inch (9.5 mm) in diameter. The reservoir is to be filled to the level recommended by the manufacturer if such level is plainly marked; otherwise, the reservoir is to be filled to maximum capacity. Additional water, equal to 50 percent of the volume just mentioned (but not more than 1 pint), is then to be poured into the reservoir. The appliance is considered to involve a risk of electric shock if the current measured through a 500 ohm resistor between an accessible part and ground is more than 5 mA.

48.1.3 For a cup or carafe warmer that incorporates ventilation or other openings through which liquid may enter, liquid entering the openings shall not wet uninsulated live parts or film-coated wires, and shall not wet electrical insulation that is likely to be adversely affected by the liquid entering the openings.

48.1.4 To determine whether a cup or carafe warmer complies with the requirement in 48.1.3, standard hard water solution consisting of 0.07oz/gal (0.5g/L) of calcium sulfate ($CaSO_4 \cdot 2H_2O$) in distilled water, is to be poured uniformly through an orifice 3/8 inch (9.5 mm) in diameter directly onto the center of the warming plate. For a warmer intended for vessels that hold up to 17.5 oz (0.51 L), then 8 oz (0.24 L) of standard hard water solution is to be used for this test. For a warmer intended for vessels that hold more than 17.5 oz (0.51 L), then 16 oz (0.47 L) of standard hard water solution is to be used for this test. The appliance is considered to involve a risk of electric shock if the current measured through a 500 ohm resistor between an accessible part and ground is more than 5 mA.

48.2 Fill

48.2.1 After testing as described in 48.2.2, an appliance that incorporates a removable container shall not permit uninsulated live parts, film-coated wire, or electrical insulation that may be adversely affected by liquid to become wet when used with the container removed.

Exception: An appliance that is marked in accordance with 67.26, is not required to be tested.

48.2.2 With the cooking container removed, 1 pint (0.47 l) of standard hard water solution (see 43.6) is to be poured into the appliance through a 3/8-inch (9.5-mm) diameter orifice in the locations likely to cause wetting of live parts and wiring. Determination of whether uninsulated live parts have become wet as a result of the test is to be made by means of a leakage current test or dielectric voltage-withstand test, or both, with the appliance de-energized. The appliance is then to be disassembled and examined for the presence of water on metal parts in the electrical component spaces that directly support electrical parts, the failure of which could result in a risk of fire or electric shock.

49 Ingress Test

49.1 To determine if a counter-top appliance, such as induction table stove, with air intake openings near the bottom, will draw liquids into the enclosure to result in risk of fire or electric shock, the appliance is to

be placed in a smooth bottomed shallow pan having at least twice the length and width of the bottom of the appliance being tested. Feet removable without use of tools shall be removed unless it is determined their removal will not affect the results. The pan is to be filled to a depth of 1/16 inch (1.6 mm) with a salt-water solution (1/2 gram of NaCl per liter of distilled water). The appliance is to be connected to a test voltage derived from its marked rated voltage in accordance with 41.1.14. and is to be operated at maximum speed for 1 minute. During this conditioning, the appliance shall comply with the Leakage Current Test, Section 38. Following this conditioning, the appliance shall comply with the Dielectric Voltage-Withstand Test, Section 44.

Exception: A counter-top machine employing bottom air intake openings and legs which space the air intake openings more than 2 inches (50.8 mm) above the counter top is not required to be tested.

50 Glass Window or Door Impact Test

50.1 A glass window or door that can be subject to contact by the user during use and routine maintenance of the appliance shall withstand an impact produced by dropping or swinging a steel sphere, 2 inches (50.8 mm) in diameter and weighing 1.18 pounds (535 g), from a height such that an impact energy of 1.5 ft lbs (2.03 Nm) is produced. The impact of the steel sphere is to be directed at or near the center of the glass window or door of the appliance. A representative sample of the appliance is to be supported as in actual service and under conditions approximating those of normal operation. Any pieces of glass created by cracking or breaking shall not be released but adhere to a plastic interlayer, as is the case for laminated or non-shattering glass, or, the glass shall fracture into small pieces without jagged edges or sharp shards, as is the case for tempered or heat-treated glass. The test is to be conducted at room temperature.

51 Handle Impact Test for Slow Cookers

51.1 The handles of a slow cooker shall withstand the ball impact produced by dropping or swinging a steel sphere, 2 inches (50.8 mm) in diameter and weighing 1.18 pounds (535 g), from a height such that an impact energy of 1.5 ft lbs (2.03 Nm) is produced. Each of three samples of the appliance handle mounted to the appliance is to be subjected to one impact on a different surface of the handle. The impact is to be imparted to the handle at a point furthest from the mounting means. The handles shall not break, loosen, crack, or be rendered incapable of supporting the appliance as intended.

52 Metal Enclosure Impact Tests

52.1 A metal enclosure part shall comply with the tests specified in this Section. For polymeric enclosure parts, see the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

52.2 A metal enclosure part shall withstand the ball impact, with the appliance restrained, as described in 52.3 without occurrence of any one of the following conditions:

a) Making live parts accessible to contact with the articulate probe, see 6.13 and 6.14.

b) Producing any other condition that results in damage of the enclosure and adversely affects 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 44, after being subjected to the impact.

52.3 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 will produce an impact of 1.5 ft-lbf (203 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 52.2, with respect to the ball drop impact test and to Figure 52.3, 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 52.1, wherein each series consists of one impact. The overall performance is acceptable upon completion of any one of the procedures represented in Figure 52.1.

52.4 With reference to Figure 52.2 and Figure 52.3, 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 52.5. 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.

Figure 52.1

Procedure for impact test

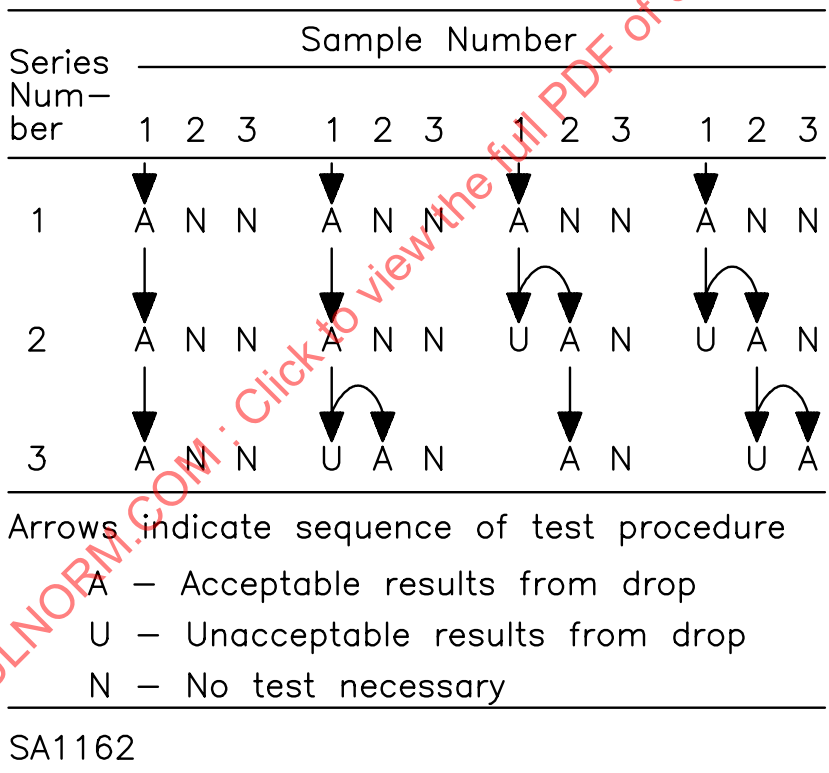


Figure 52.2

Ball drop impact test

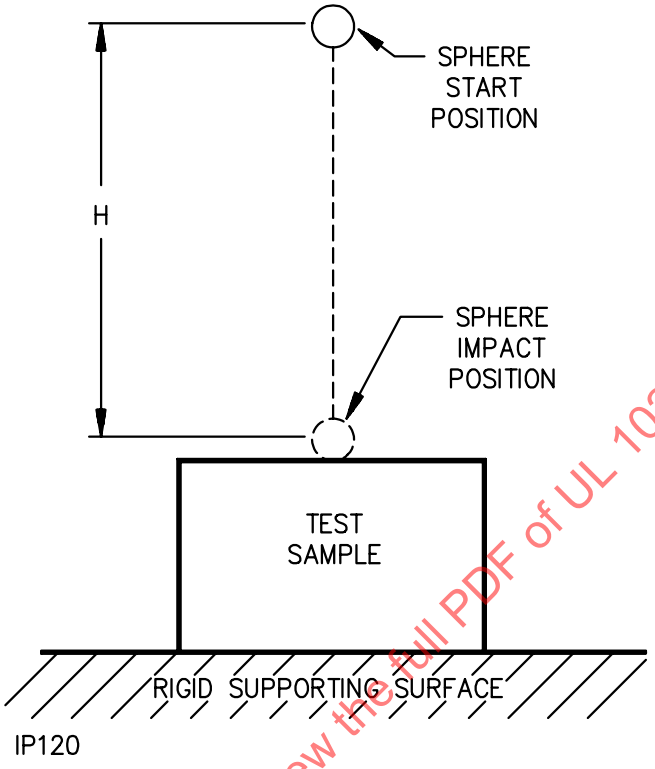
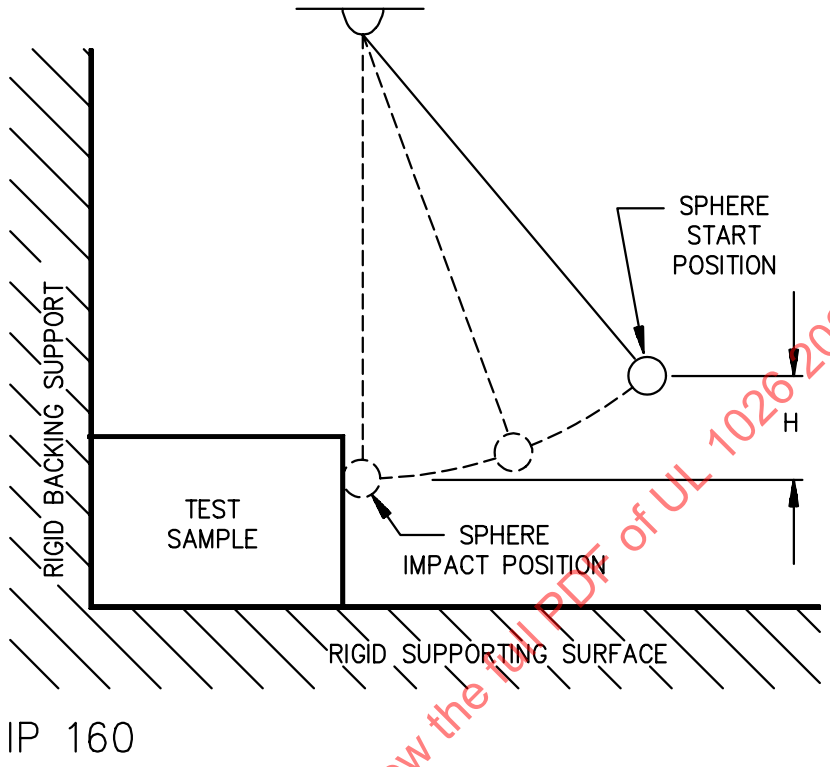


Figure 52.3

Ball pendulum impact test



52.5 The supporting surface mentioned in 52.4, 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 inch by 2-1/4 inch (actual size 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.

53 Non-Metallic Enclosure-Fasteners Test

53.1 An enclosure or enclosure part secured by non-metallic fasteners shall not become detached and shall remain in the secured position when tested in accordance with this Section. An enclosure or part that requires removal to perform manufacturer's recommended user servicing, maintenance, operating adjustments, attachment of accessories, and the like, is to be disassembled and assembled 10 times before the test is conducted. The tests are to be performed on a total of six samples; three samples as-received, and three samples that have been conditioned by operating until constant temperatures are obtained in accordance with Normal Temperature Test, Section 41. The test is to be commenced within one minute after completion of the conditioning of the three samples.

Exception: For a polymeric enclosure not fabricated with thermoplastic materials, only the as-received samples are to be tested.

53.2 Each sample is to be subjected to push and pull forces as specified below. The forces are to be applied in any direction likely to result in non-compliance:

a) A push force of 11.2 lbf (50 N); and

b) A pull force:

1) Of 11.2 lbf (50 N), if the shape of the part is such that the fingertips cannot easily slip off; or

2) 6.7 lbf (30 N), if the projection of the part which is gripped is less than 0.4 inch (10 mm) in the direction of removal.

The force is to be applied gradually at a uniform rate until the specified value is obtained. The force is then to be maintained for 10 seconds. For each of the samples tested, the point of application and direction of the force is to be different.

53.3 The push force is to be applied by means of a rigid probe of the dimensions shown in Figure 53.1. The pull force is to be applied by an acceptable means such as a wire through an opening in the enclosure that does not affect the securement means of the enclosure or enclosure part being evaluated, so that the test results are not affected.

53.4 While the pull force specified in 53.2(b), is being applied, the test fingernail shown in Figure 53.2, is to be inserted in any aperture or joint with a force of 2.24 lbf (10 N). The fingernail is then to be slid sideways with a force of 2.24 lbf (10 N). The fingernail is not to be twisted or used as a lever.

53.5 If the shape of the part is such that an axial pull is unlikely, no pull force is to be applied but the test fingernail shown in Figure 53.2, is to be inserted in any aperture or joint with a force of 2.24 lbf (10 N) and then is to be pulled for 10 seconds by means of the loop with a force of 6.7 lbf (30 N) in the direction of removal.

53.6 If the enclosure or enclosure part is likely to be subjected to a twisting force, a torque as specified below is to be applied at the same time as the pull or push force:

a) For major dimensions up to and including 2 inches (50.8 mm) – 17.7 in.-lbf (2 N·m).

b) For major dimensions over 2 inches – 35.4 in.-lbf (4 N·m).

The torque is also to be applied when the test fingernail is pulled by means of the loop.

53.7 If the projection of the enclosure or enclosure part that is gripped is less than 0.4 inch (10 mm), the torque as specified in 53.6, is to be reduced to 50 percent of the value.

Figure 53.1

IEC accessibility probe with stop plate

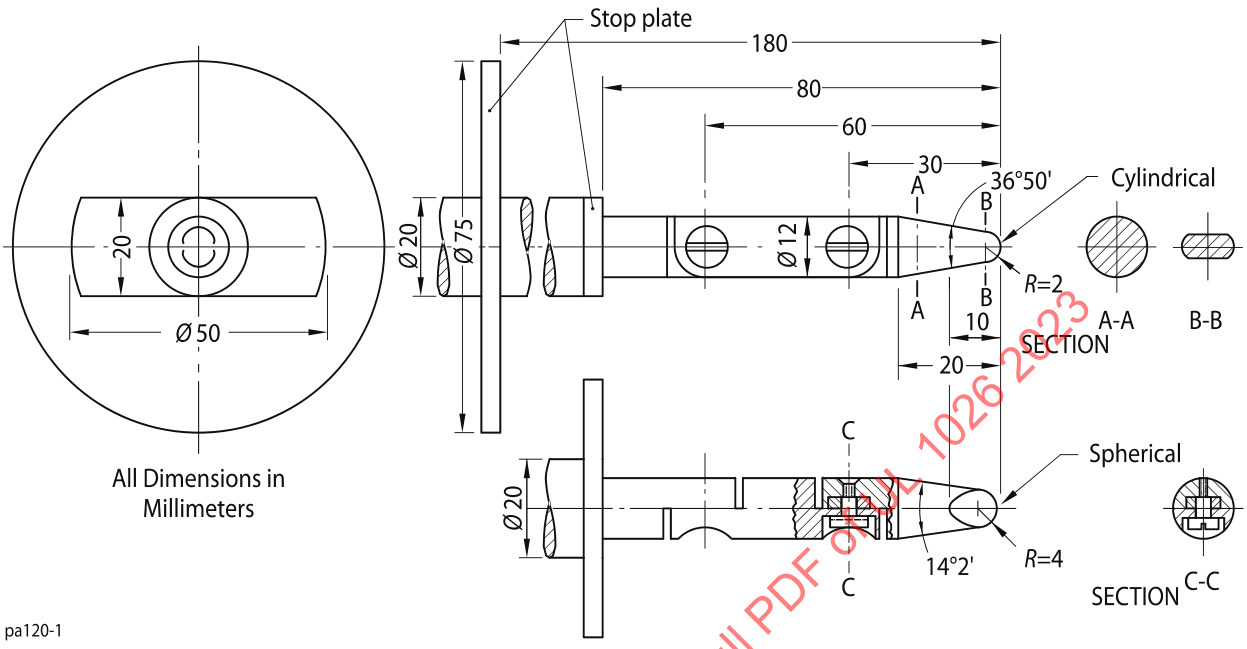
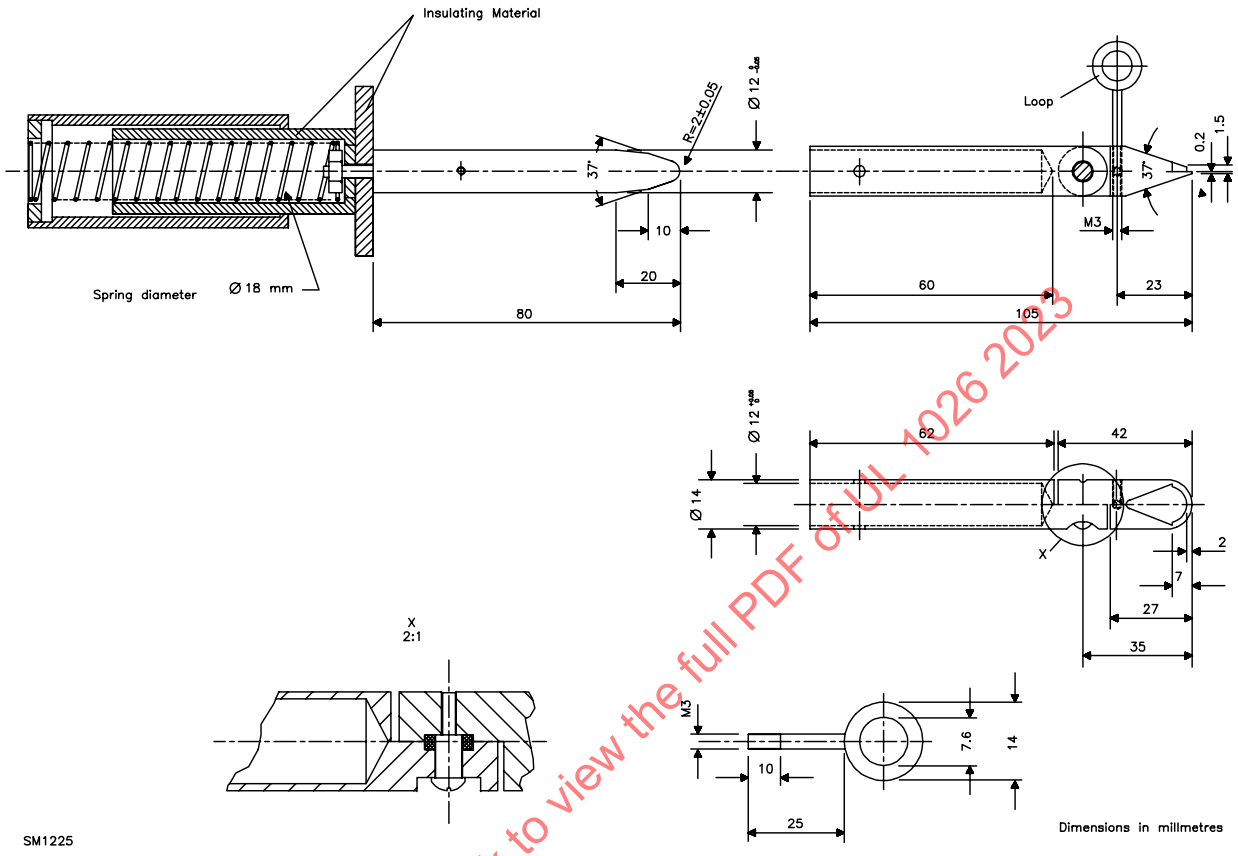


Figure 53.2

Test fingernail



54 Thermal Degradation Test

54.1 A thermoset material used as a functional 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 product 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.

54A Oven Rack Loading Test

54A.1 An oven rack shall not fall from its supports, the test weight shall not slide off the rack and the appliance shall not tip when tested per 54A.2 – 54A.5. Testing shall be performed with the appliance at ambient temperature except for 54A.4.

54A.2 The test is to be conducted using the pan supplied with the appliance. If a pan is not provided, a pan suitable for the appliance is to be used.

54A.3 With the oven rack in the lowest position and fully inserted in the toaster oven, the pan with the test weight of Table Table 54A.1 (evenly distributed on the pan) is placed on the center of the rack. The test weight includes the weight of the pan.

The rack is then pulled out over a period of approximately 2 seconds until contacting the rack stop. If a rack stop is not provided with the unit, the rack shall be pulled out to a distance measuring approximately 50 percent of the rack depth dimension, as measured from the inner plane of the opening where the rack exits the appliance. The rack is to remain fully extended for a period of 60 seconds. The test is repeated with the oven rack in all possible orientations and positions.

54A.4 The appliance is then to be operated at the maximum temperature setting for a minimum of 1 hour, with the oven racks in place, but without the test weight. The test of 54A.3 is then repeated. The appliance shall be allowed to recover to the initial temperature between each rack position or location test.

54A.5 Following the test in 54A.4 a sufficient cool-down period is to be allowed for the appliance to return to its ambient temperature. The test of 54A.3 is then repeated.

Table 54A.1
Test weight (including test pan)

Usable volume[1]	Weight
<= 500 cubic inches (8194 cubic centimeters)	4 lbs (1.8 kg)
> 500 cubic inches (8194 cubic centimeters)	8 lbs (3.6 kg)

[1] For calculation of usable volume, usable height is from the top of the rack to the bottom of the upper heating element or other physical barrier below the upper heating element.
Exception: If provided in the instruction manual, the manufacturer's recommendations regarding spacing from the heating elements shall be followed when determining the usable height.

55 Abnormal Operation Test

55.1 General

55.1.1 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.

55.1.2 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.

55.1.3 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 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 shall be as described in 55.1.4.

55.1.4 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.

55.1.5 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 41.1.14 – 41.1.23. Accessible metal parts, those that can be contacted by the probe in Figure 6.2, and metal parts accessible during user-servicing are to be connected to ground through a 3-Amp fuse. In most cases, continuous operation for 7 to 8 hours will be necessary to determine the ultimate result.

55.1.6 A counter-top appliance, including a table stove and a front- or side-loaded appliance, is to be located as close to the walls of the test corner as the construction permits. The test corner is also to be provided with a 12-inch (305-mm) deep, simulated cabinet bottom, located 16 inches (406 mm) above the counter top. The cabinet bottom is to consist of dull black-painted fir plywood 3/8 inch (9.5 mm) thick.

Exception No. 1: An appliance such as a yogurt maker, slow cooker, and the like with relatively low surface temperatures are typical appliances that need not be tested in an alcove corner.

Exception No. 2: An appliance intended for outdoor use only need not be tested in a test corner.

Exception No. 3: 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 (559 mm) high, the cabinet bottom is to be omitted.

Exception No. 4: When the test specifies the use of an indicator test panel over the appliance, the cabinet bottom is to be omitted.

55.1.7 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, in the case of a permanently installed appliance, that may be in proximity to the appliance as installed.

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

55.1.9 After having been subjected to an abnormal test, a cord-connected appliance is considered to involve a risk of electric shock if the current measured through a 500 ohm resistor between an accessible part and ground is more than 5 mA. The current need not be measured at terminals operating at voltage levels less than 42.4 V peak. In the case of an appliance utilizing a liquid in its normal operation, the liquid container is to be filled with the hard water solution described in 43.6, in the intended manner, prior to the current measurement. Liquid need not be added if it is obviously apparent that the appliance will not hold liquid. Otherwise, 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.

55.1.10 After having been subjected to an abnormal test, a permanently-connected appliance shall be subjected to a repeated Dielectric Voltage-Withstand Test as described in Section 44.

55.1.11 If a motor is connected across a portion of a resistance element, the appliance shall not present risk of fire or electric shock as the result of an open circuit in the portion of the element that is in parallel with the motor.

55.2 Specific test conditions

55.2.1 General

55.2.1.1 For most of the common types of appliances, standardized abnormal test conditions are given in 55.2.2.1 – 55.2.8.1.

55.2.2 Appliances with breakable exterior surfaces

55.2.2.1 If an appliance (such as a warming tray, food warmer, induction table stove) 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.

55.2.2.2 Certain specific tests are described in 55.2.3.1 – 55.2.3.5, but other tests may be necessitated by the design or intended operation of the appliance.

55.2.3 Appliances with breakable surfaces

55.2.3.1 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 43.6) at room temperature, with the appliance in the fully heated condition. The quantity of water involved shall wet the surface completely.

a) A cord-connected appliance rated for a nominal 120-V or 240-V supply shall comply with the requirement in 38.1, in a repeat leakage current test, except that the test shall be discontinued when leakage current stabilizes.

b) An appliance other than those specified in (a) shall have an insulation resistance of not less than 50,000 ohms.

55.2.3.2 The horizontal glass or ceramic food warming surface or induction cooking surface of an appliance shall withstand without cracking or breaking the impact of a steel sphere, 2 inches (51 mm) in diameter and weighing 1.18 pounds (535 g), dropped from a height of 20.25 inches (514 mm). Four drops shall be made at different places on separate samples.

Exception: Breakage or cracking of the surfaces as a result of the test is acceptable if the leakage current, when measured as described in 55.2.3.3 and 55.2.3.4, does not exceed the limits described in 55.1.9, and acceptable results are obtained following a repeated Dielectric Voltage-Withstand Test as described in Section 44.

55.2.3.3 With reference to the Exception to 55.2.3.2, to determine whether a broken or cracked surface is acceptable, a solution of 500 cubic centimeters of water containing 1/4 gram of ordinary table salt is to be spilled over the broken or cracked area of the surface. A layer of metallic foil is then to be placed over the surface. The foil is to be covered with a 1-inch (25.4-mm) thick layer of 1 lb/ft^3 (16 kg/m^3) glass fiber insulation. A 10-inch (254-mm) diameter pan filled with enough water to make it weigh 10 lb (4.54 kg) is then to be placed on the insulation directly over the broken or cracked area. The leakage current is then to be measured in accordance with 55.1.9.

55.2.3.4 The leakage current between the metallic foil and live parts of the appliance is to be measured as soon after the water-salt solution has been poured on the surface as is possible. For the test, the appliance frame is to be connected to the metallic foil. The Dielectric Voltage-Withstand Test shall be conducted immediately after the leakage current measurement.

55.2.3.5 An appliance other than a warming tray, 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 lbf (1.81 kgf) 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 ten 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 surface as a result of the test is acceptable if the leakage current when measured as described in 55.2.3.3 and 55.2.3.4 does not exceed the limits described in 55.1.9 and acceptable results are obtained following a repeated Dielectric Voltage-Withstand Test as described in Section 44.

55.2.4 Barbecue units and grill-type broilers

55.2.4.1 An electrically heated grill-type broiler, barbecue unit, or the like shall comply with the flare-up-test requirements in 55.2.4.3 – 55.2.4.7 if:

a) The heat source is below the cooking surface; and

b) The temperature of the heat source has an average value higher than 260°C (500°F) or a maximum value higher than 300°C (572°F); and

c) The use of the appliance, if cord connected is not restricted to outdoor or fireplace use by a marking in accordance with 67.8.

55.2.4.2 A solid-fuel-fired grill-type electric broiler, barbecue unit, or the like is not acceptable for indoor use unless connected to a chimney in accordance with the Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances, NFPA 211.

55.2.4.3 There shall be no ignition of an indicator test panel as the result of flame from burning fat or grease when the appliance is performing its intended function when tested in accordance with 55.2.4.4 – 55.2.4.7. The regulating thermostat is not to be defeated during this test.

55.2.4.4 The test panel is to consist of two layers of cheesecloth (see 41.1.28) secured to a wire frame in such a manner that no loose thread ends are visible on the underside. The area of the panel is not to be less than the active area of the heating element and is not to be larger than 4 inches (102 mm) beyond the sides of the appliance enclosure.

55.2.4.5 After the appliance has been subjected to maximum normal heating for 10 minutes, the cooking surface above the active element area is to be covered uniformly with 3-inch (76-mm) diameter, 1-inch (25.4-mm) thick pats of hamburger beef (adjacent edges touching before cooking begins) consisting of a mixture of 50 percent each by weight of lean beef and suet that have been ground together twice in succession.

55.2.4.6 During the broiling of the beef pats on both sides, the indicator test panel is to be supported 8 inches (203 mm) above and parallel to the cooking surface. The panel is to remain in place throughout the test except when necessary manipulations of the meat occur, such as placing the meat on the cooking surface, turning the meat over, or removing it. Flare-ups which occur as a direct result of such manipulation are to be allowed to subside or are to be deliberately extinguished, as by lifting the meat away from the cooking surface, before the test panel is replaced. A second loading of hamburgers is to be cooked immediately following completion of the first cycle.

55.2.4.7 During both test cycles, melted fat is to be allowed to accumulate in the intended manner except that any instructions for adding water or other similar material to the fat receptacle are to be disregarded.

55.2.5 Toasters, toaster ovens, and toaster oven/broilers

55.2.5.1 A toaster is to be operated as described in 55.1.5, without toast and with doors, or the equivalent, closed. In the case of an automatic toaster, any means employed for de-energizing the heating elements is to be defeated.

55.2.5.2 There shall be no ignition of either the food load or the indicator test panel when an automatic toaster is operated as described in 55.1.5 with all means for disconnecting any heating element shunted out of the circuit except the supplemental operating control described in 22.18. Throughout the test, the wattage described in 41.1.14 shall be maintained. Four conditions are to be tested, and each condition is to be repeated on a second sample, for a total of eight tests. Separate samples may be used for each condition. The toaster is to be loaded initially for the first test with one slice of white bread and then to a maximum capacity for the second test. The third and fourth tests are to be the same as tests one and two, except using frosted toaster pastries in place of the white bread. The food load is to be located at the center of the bread slot and in an outside slot for a multiple-slot toaster when using single slice. The food load should be oriented with its long axis parallel to the direction of travel of the bread carriage. The bread carriage shall remain in the toasting position throughout the test. The white bread is to be commercially available white bread as described in 55.2.5.6, and the frosted toaster pastry is to be commercially

available undamaged (whole) hard-frosted, strawberry fruit-filled toaster pastry. Each pastry shall weigh approximately 52 g, with a stated sugar content of 16 g ±1 g, and a stated calorie amount of 200 ±10.

55.2.5.3 For the test described in 55.2.5.2 the test panel is to be that described in 55.2.4.4, and is to be supported 8 inches (203 mm) above and parallel to the top of the toaster. The toaster shall be placed on a heat resistant surface in a draft-free location, with a clearance of at least 12 inches around all sides of the toaster. For each cycle, if a supplemental operating control is provided, the time from energization of the toaster elements to when the supplemental operating control disconnects the ungrounded conductor of the power supply shall be recorded.

Exception: For under-cabinet mounted toaster, the test panel shall be located on the surface directly above the toaster, with the closest spacing the mounting means will allow.

55.2.5.4 An automatic toaster is to be operated with a simulated toast load as described in Figure 60.1, with the color setting of the toaster set to minimum, to determine the length of time for a toast cycle at this setting. This operation is to be repeated with the simulated toast load artificially jammed at its normal toasting position in the toaster slot to prevent its movement. As a result of this test, the heating elements of an automatic toaster shall de-energize upon completion of the toast cycle.

55.2.5.5 The two operations described in 55.2.5.4, shall be repeated with the color setting of the automatic toaster set to maximum. As a result of this test, the heating elements of an automatic toaster shall de-energize upon completion of the toast cycle.

55.2.5.6 There shall be no ignition of the bread load when a toaster oven or toaster oven/broiler is operated in the toasting mode for one cycle with the color setting set to maximum darkness. The appliance is to be loaded with any load up to maximum recommended capacity. Slices of commercially available white bread, each weighing approximately 25 g are to be used. If the toasting cycle does not terminate automatically, operation is to continue until ultimate results are obtained. The regulating thermostat is not to be defeated during this test.

55.2.5.7 A toaster oven or toaster oven/broiler is to be operated without any food load in the toasting mode with all temperature controls, other than the temperature limiting device, defeated.

55.2.5.8 A toaster oven or toaster oven/broiler is to be operated at its maximum temperature setting in the oven mode, in its intended operating position, with the crumb tray in such a position as to cause maximum heating of the supporting surface. If the crumb tray is removable, it is to be removed. The temperature regulating control is not to be defeated for this test. Temperatures of the supporting surfaces shall comply with Table 41.1.

55.2.5.9 With the oven door shut, the broiler pan removed, and crumb tray in place, a toaster oven or toaster oven/broiler is to be operated as described in 55.1.5, except that it is to be surrounded on five sides (top, front, back, left side, and right side) with two layers of cheesecloth (see 41.1.28). The cheesecloth is to be held in place by a steel wire frame extending out horizontally roughly 1 inch (25.4 mm) from the five exposed sides of the toaster oven. The toaster oven is to be placed on a supporting surface covered with two layers of tissue paper. For under-the-cabinet installation, a toaster oven or toaster oven/broiler is to be surrounded on five sides (bottom, front, back, left side, and right side) with two layers of cheesecloth held in place by a steel wire frame extending out horizontally roughly 1 inch (25.4 mm) from the five exposed sides of the toaster oven. For under-the-cabinet installation, the cheesecloth shall extend 3 inches (76.2 mm) vertically above the top of the front of the appliance. A toaster oven or toaster oven/broiler provided with an automatic door opening feature is to have its door opened after the bread-load has ignited.

55.2.5.10 There shall not be any emission of flame as determined by ignition of the cheesecloth when a toaster oven or toaster oven/broiler is operated with a bread load conditioned as described in 55.2.5.12.

Charring of the cheesecloth does not constitute a failure. Two tests are to be performed. The toaster oven or toaster oven/broiler is to be loaded initially for the first test with one slice of bread centered on the toasting surface and then to the manufacturer's specified maximum capacity with the bread equally spaced on the toasting surface for the second test. The slices of bread are to be ignited by:

a) Repeatedly applying the toast cycle; or

b) Operating the oven cycle (if any); or

c) Having all temperature regulating devices defeated (non-resettable temperature limiting devices need not be defeated)

The toast is to be allowed to burn until it is completely consumed, or until the flaming ceases.

55.2.5.11 If the bread load does not ignite within 15 minutes of the start of the test described in 55.2.5.10, the test is to be repeated with a new bread load and with the voltage increased by 5 Volts. If need be, this test procedure is to be repeated, each time with a new bread load and voltage increased by an additional 5 Volts, until ignition of the bread load occurs.

55.2.5.12 The bread is to be commercially available white bread weighing approximately 25 g. The bread is to be dried for one hour in open air at approximately 25°C (77°F) with 50 percent relative humidity before the toaster oven or toaster oven/broiler is operated, as described in 55.2.5.10.

55.2.6 Warming trays and food warmers

55.2.6.1 The appliance is to be operated with the entire serving surface covered with a double layer of cheesecloth and with a 1-inch thick (25-mm) hair-felt pad. If the thermostat cycles, the test is to be repeated with only two thirds of the serving surface covered and again with one-third of the serving surface covered. In the partial coverage test, the area of the tray farthest from the thermostat is to be covered. Operation under each of the above conditions is to be continuous for a period of 7 hours.

55.2.7 Broiler/ovens

55.2.7.1 A broiler, an oven, or a broiler/oven is to be operated at the maximum temperature setting until constant temperatures are obtained without any food load.

55.2.8 Table stoves

55.2.8.1 A sample of the appliance is to be operated continuously with each heating until covered with a cast-iron circular stove plate. An additional sample is to be operated in the same manner but with an aluminum plate. The cast iron plate to be used with a 6 inch (152 mm) or smaller surface unit is 7 – 8 inches (178 – 203 mm) in diameter and weighs approximately 3 lb (1.36 kg). The cast iron plate to be used with a larger surface unit is 10 – 11 inches (254 – 279 mm) in diameter and weighs approximately 7 lb (3.18 kg). The aluminum plates are to be of the same dimensions indicated above, except 1/4 inch (6.4 mm) thick and no weight is specified.

55.2.8.2 When the size of the table stove is such that when the stove plate is centered on a surface unit the plate touches the wall, the test is to be conducted with the table stove positioned as follows:

a) With the plate centered on a surface so that the plate touches the wall; and

b) With the plate off center and the stove as close to the wall as possible with the plate stable and touching wall.

55.2.8.3 In addition to the applicable test described in 55.2.1.1 – 55.2.8.2, a dual voltage appliance shall be subjected to the tests described in 55.1.2 – 55.1.4. These tests are subject to the test conditions described in 55.1.5 and 55.1.6, and to the acceptance criteria described in 55.1.7 – 55.1.11. There shall be no electrical or mechanical breakdown of the voltage selector switch.

55.2.9 Induction table stove

55.2.9.1 Induction table stove is tested as described in 55.2.8.1 – 55.2.8.3, except tested with cast iron plate.

55.2.10 Component failure test

55.2.10.1 If an appliance employs one or more rectifiers, transistors, or similar solid-state components, a risk of fire or electric shock shall not develop when the circuit between any two terminals of any such component is open-circuited or short-circuited. If the appliance employs a capacitor in combination with one or more of the above-mentioned components, a risk of fire or electric shock shall not develop when the capacitor is short-circuited. Only one of the simulated fault conditions described above is to be imposed at one time. See 55.2.10.2 – 55.2.10.5. The test is to be conducted three times using new components when necessary only if burnout occurs.

Exception: Components located on the secondary of a Class 2 transformer need not comply with these requirements unless the components are located in the safety circuit.

55.2.10.2 If a semiconductor rectifier is employed, three appliances are to be tested with the rectifier terminals connected together. Three additional appliances are to be tested with the terminals of the electrolytic capacitor connected together.

55.2.10.3 Three complete tests are to be made under each of the conditions described in 55.2.10.2, using new components in each test. The appliance to be tested is to be connected as indicated in 55.1.5.

55.2.10.4 An unacceptable condition exists if flame is emitted from the overall enclosure of the appliance or if a permanently conductive path is established between live parts and exposed dead metal.

55.2.10.5 The tests described in 55.2.10.1 – 55.2.10.3, may be omitted if one or both of the following conditions exist:

a) There is 10,000 ohms or more of additional series impedance in a circuit in which the voltage does not exceed 125 V; and/or

b) There is 20,000 ohms or more of additional series impedance in a circuit in which the voltage may be more than 125 but is no more than 250 V.

55.2.10.6 A single fault condition as described in 55.2.10.1 shall not result in a condition where both the normal and supplemental operating controls fail to open the circuit.

56 Impact Test for Under-Cabinet and Wall-Mounted Appliances

56.1 The impact test of 56.2, shall be conducted on all under-cabinet and wall-mounted appliances without occurrence of any of the following conditions:

a) Making live parts accessible to contact with the articulate probe (see 6.13 and 6.14);

b) Producing any other condition that results in damage of the enclosure that adversely affects 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 44, after being subjected to the impact; and

d) Dislodging of the appliance or separable parts of the appliance.

56.2 A 1-1/2 ft-lbf (2.0 N·m) impact is to be performed on all exposed sections of the enclosure, while the unit is installed under a cabinet or on a wall. Each of three samples is to be subjected to one impact on each surface. The impact is to be imparted by swinging a 2-inch (50.8-mm) diameter steel sphere, weighing 1.18 lb (0.535 kg) from a height that will produce an impact of 1-1/2 ft-lbf (2.0 N·m).

Exception No. 1: The impact is not required to be applied to glass surfaces.

Exception No. 2: If the manufacturer elects, fewer than three samples may be used for the test in accordance with Figure 52.1, wherein each series consists of one impact. The overall performance is acceptable upon completion of any one of the procedures represented in Figure 52.1.

57 Loading Test

57.1 A loading test is to be performed on the mounting brackets of an under-cabinet or wall-mounted appliance with the appliance mounted in accordance with the manufacturer's installation instructions, using the hardware and construction as described. A bracket shall not break, loosen, or pull out of the wall nor shall any portion of the unit attached to the mounting means be adversely affected as a result of this test.

57.2 The test load is to consist of the weight of the appliance plus three times the maximum normal load (food load, water, grounds, basket, and the like, based on cavity size and maximum recipe book weight recommendations). A gradually increasing force is to be applied to act vertically through the center of the gravity of the unit. The force is to be increased in a 5 to 10 second interval until the test load is applied to the mounting system and is to be sustained for a period of 1 minute. For this test an under-cabinet unit is to be mounted on a wood board with a minimum thickness as specified by the manufacturer and a wall unit is to be mounted on 3/8 inch (4.8 mm) thick wall board.

57.3 If the mounting brackets are constructed of a thermoplastic material, they are to be conditioned for 7 hours in an air circulating oven maintained at 70°C (158°F) or 10°C (18°F) higher than that measured during the normal temperature test, whichever is higher, prior to performing the loading test.

58 Handle Strength Test for Slow Cookers

58.1 The handles of a slow cooker shall not break, loosen, crack, or be rendered incapable of supporting the appliance as intended as a result of the handle strength test specified in 58.3 – 58.6. If non-metallic handles are employed, the material shall be subjected to the criteria in 58.2 prior to conducting the handle strength test.

58.2 A non-metallic material used for the handles of a slow cooker 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 are to be investigated by one of the following procedures:

a) The material shall have a temperature index (RTI), 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 slow cooker shall be operated with the input voltage adjusted so that the handle 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.

58.3 To evaluate the handles of the heating base, a slow cooker is to be loaded so that the handles support a weight equivalent to three times the total weight of: the unit, lid, and separate cooking vessel (if present) filled with water to the overflow capacity. To arrive at the appropriate test load, each component of this test is to be weighed individually, added to the total, and the total multiplied by three. The test load is to be distributed so that the normal horizontal center of gravity is not changed.

58.4 aTo evaluate the handles of a separate cooking vessel, the cooking vessel is to be loaded so that the handles support a weight equivalent to three times the total weight of: the vessel plus the weight of water equal to the maximum overflow capacity of water. The test load is to be distributed so that the normal horizontal center of gravity is not changed.

58.5 The weighted slow cooker is to be mounted to a test fixture such that the handle is held over a 2 – 4 inch (51 – 102 mm) wide gripping area and centered over the intended gripping area. Due to limitations of handle design, a smaller width gripping area may be used. If more than one handle is employed, the weight is to be distributed between the handles. The test fixture shall provide a dynamic load upon the handles by lifting the slow cooker at least 12 inches (305 mm) in 1 second of time and then lowering the slow cooker. The test is to be performed while the slow cooker is in a well heated condition and energized at the test voltage in 41.1.14, at the setting producing the highest handle temperatures during the Normal Temperature Test, Section 41. The dynamic loading test shall be repeated for a total of 5000 cycles.

58.6 The test in 58.5, is to be repeated with a separate sample of a slow cooker unenergized at ambient temperature.

59 Temperature Probe Insertion Test

59.1 Each of six samples is to be subjected to 50 cycles of insertion and withdrawal of the temperature-probe plug. The cycles are to be performed manually at a rate of speed no greater than 6 cycles per minute, under rated load. At the completion of the 50 cycles, the voltage drop at rated current shall not exceed 50 mV between the male and female contacts of the temperature probe plug. There shall be no mechanical failure of the temperature probe plug, nor shall there be any undue deterioration, pitting, or burning of the probe contacts.

60 Component Switches and Control Devices

60.1 Overload

60.1.1 Motor switches

60.1.1.1 A switch or other device that controls a motor employed in an appliance, unless acceptable for the application or unless interlocked so that it will never have to break the locked-rotor motor current, shall be capable of performing acceptably when subjected to an overload test consisting of 50 cycles of operation, making and breaking the locked-rotor current of the motor. There shall be neither electrical nor mechanical malfunction of the device, nor undue burning, pitting, or welding of the contacts.

60.1.1.2 To determine whether a switch or other control device is capable of performing acceptably in the overload test, the appliance is to be connected to a grounded supply circuit of rated frequency and voltage in accordance with 41.1.14, with the rotor of the motor locked in position. During the test, exposed dead metal parts of the appliance are to be connected to ground through a 3-Amp fuse, and the current-interrupting device, if single-pole, is to be located in an ungrounded conductor of the supply circuit. If the appliance is intended for use on direct current, or on direct current as well as alternating current, the overload test is to be conducted with direct current, and exposed dead metal parts are to be connected so

that they are positive with respect to a single-pole, current-rupturing device. The device is to be operated at the rate of 10 cycles per minute, except that a faster rate of operation may be employed if agreeable to all concerned. The performance is unacceptable if the fuse in the grounding connection opens during the test.

60.1.2 Automatic controls

60.1.2.1 An automatic control for temperature regulating or temperature limiting shall be capable of performing successfully for 50 cycles of operation, when the heater is connected to a supply circuit having a potential of 120 percent of the voltage specified in 41.1.14. There shall be neither electrical nor mechanical malfunction of the control, nor undue burning, pitting, or welding of the contacts.

60.1.2.2 In tests to determine whether an automatic control complies with the requirements in 60.1.2.1 and 60.1.2.3, the appliance is to be connected to a grounded supply circuit; the enclosure of the appliance, if of metal, is to be connected to ground through a 3-Amp fuse; and the control, if single-pole, is to be connected in an ungrounded conductor of the circuit. If the heater is intended for use on direct current, or on direct current as well as on alternating current, the test is to be conducted with direct current, and the enclosure is to be connected so that it is positive with respect to a single-pole automatic control. The device is to be operated at the rate of 6 cycles per minute, except that a faster rate of operation may be employed if agreeable to all concerned. The performance is unacceptable if the fuse in the grounding connections opens during the test.

60.1.2.3 An automatic control intended for use on direct current, which is constructed so that the starting handle does not stay latched with the timing knob in all of its position settings, thereby resulting in a slow break of the switch contacts upon release of the handle, shall be capable of performing successfully when tested as follows. The switch shall be subjected to 50 cycles of operation at normal load by releasing the handle slowly and, during the test, the metal frame of the appliance shall be connected to ground through a 3-Amp fuse to give indication of a flashover, should this occur. The test shall be made following the overload test and preceding the endurance test on the control. See 60.1.2.1 and 60.2.1.1.

Table 60.1
Number of cycles of operation for endurance test

Type of thermostat	Automatically reset thermostat	Manually reset thermostat
Temperature regulating	A number of cycles equivalent to 1000 hours of intended operation of the appliance, but not less than 6000 cycles. However, the test may be omitted if, with the thermostat short-circuited, no temperature higher than the limits given in Table 41.1 are attained during the normal-temperature test of the appliance.	To be made the subject of special consideration[a]
Temperature-limiting[b]	A number of cycles equivalent to 100 hours of operation of the appliance under any condition which causes the thermostat to function, or 100,000 cycles, whichever is greater. However, the test may be omitted if, with the thermostat short-circuited, there is no evidence of risk of fire as described in 55.1.1 – 55.1.11 during the continuous abnormal operation of the appliance.	1000 cycles underload and 5000 cycles without load. However, the test may be omitted if, with the thermostat short-circuited, there is no evidence of risk of fire as described in 55.1.1 – 55.1.11 during continuous abnormal operations of the appliance.
Combination temperature-regulating and -limiting	100,000 cycles if, with the thermostat short-circuited, there is evidence of fire as described in 55.1.1 – 55.1.11. If there is no evidence of risk of fire under this condition,	To be made the subject of special consideration.

Table 60.1 Continued on Next Page

Table 60.1 Continued

Type of thermostat	Automatically reset thermostat	Manually reset thermostat
	the thermostat is to be tested as a temperature-regulating thermostat (see above).	

[a] If the operation of the thermostat controls the physical movement of a part of the appliance (such as in a pop-up type of automatic toaster), the test is to be arranged so that each cycle involves the complete intended operation of the appliance.

[b] See 28.1 and 28.2.

60.2 Endurance

60.2.1 Thermostats

60.2.1.1 A thermostat shall be capable of withstanding an endurance test which shall consist of the number of cycles indicated in Table 60.1. Unless it is specified that the test be made without load, the thermostat shall make and break the rated current of the appliance while connected to a circuit of rated voltage. There shall be neither electrical nor mechanical malfunction of the thermostat, nor undue burning, pitting, or welding of the contacts.

60.2.1.2 With reference to 60.2.1.1 and Table 60.1, thermostats are classified as follows:

a) A temperature-regulating thermostat is one which functions only to regulate the temperature of the appliance under normal conditions of use, and whose malfunction does not result in a risk of fire.

b) A temperature-limiting thermostat is one which functions only under conditions which produce abnormal temperatures. The malfunction of such a thermostat might or might not result in a risk of fire.

c) A combination temperature-regulating and -limiting thermostat is one that functions to regulate the temperature of the appliance under normal conditions of use, and also serves to reduce the risk of a fire that might result from conditions of abnormal operation of the appliance.

60.2.2 Automatic toasters

60.2.2.1 An automatic toaster shall be capable of withstanding an endurance test consisting of 6000 cycles of operation while loaded as outlined in 60.2.2.2. A complete cycle shall consist of the switch contacts making and breaking the rated current of the toaster and, except as indicated in 60.2.2.2, movement of the elevator mechanism completely throughout its normal travel. There shall be no electrical or mechanical malfunction with regard to opening the contacts and no welding or undue pitting of the switch contacts. In addition, the toaster shall comply with the test described in 55.2.5.2 and 55.2.5.3, following the endurance test.

60.2.2.2 With reference to 60.2.2.1, each bread slot or space is to be loaded with a 50 g weight for the first 25 cycles and last 25 cycles, and a 25 g weight for the intervening 5950 cycles. The weights are to consist of the simulated toast load described in Figure 60.1. Lead shot (No. 7) is to be added to the simulated toast load as necessary to obtain the exact weights of the total loads. During the cycles using the 50 g weights, the elevator mechanism need not move through its complete travel but shall open the switch contacts providing power to the heating elements.

60.2.2.3 During the endurance test described in 60.2.2.1 and 60.2.2.2, external fan cooling may be provided to shorten the cycle time, however, the temperatures obtained adjacent to temperature sensing components or other appropriate reference points shall not exceed those measured during the normal

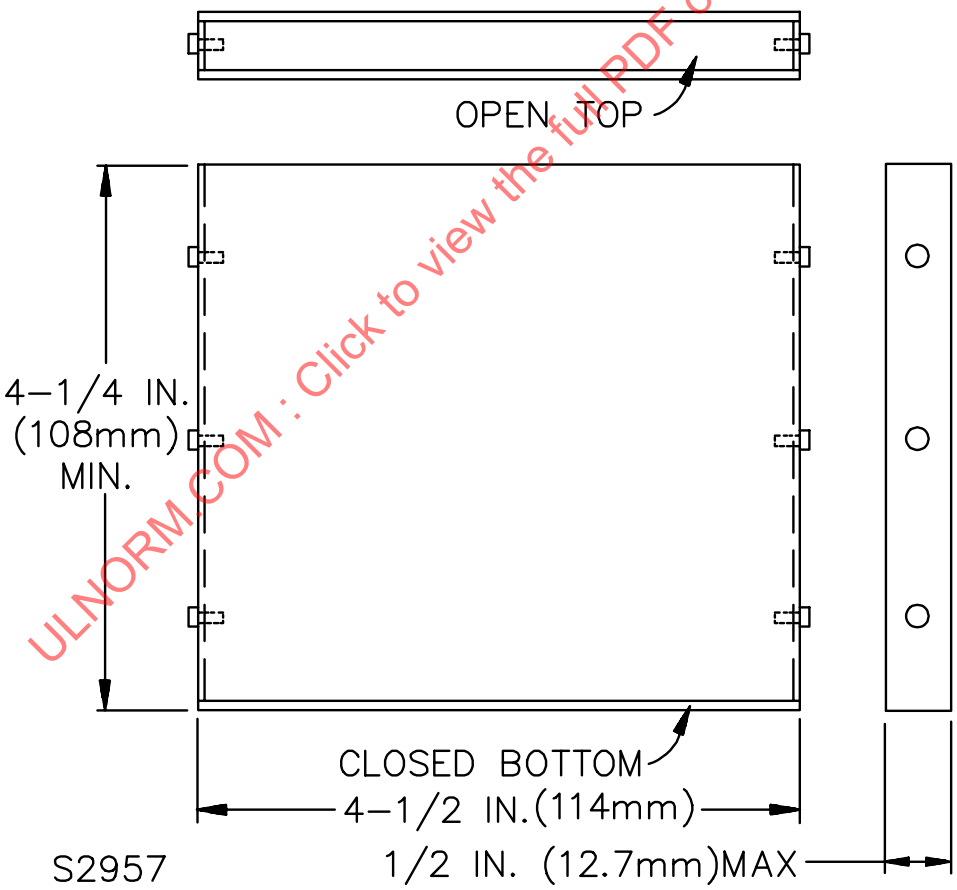
temperature test described in 41.2.5.1. Operation is to consist of simulating the toasting of bread with each cycle terminated by the toaster automatically.

60.2.2.4 The automatic toast feature of a toaster oven shall be capable of withstanding an endurance test consisting of 6000 cycles simulating the process of making toast. A complete cycle shall consist of the initiation of the toast cycle through use of the toast feature actuator, heating the oven to normal operating temperature and termination of the toast cycle by the toaster automatically. There shall be no electrical or mechanical malfunction with regard to opening the contacts, and there shall be no welding or undue pitting of the switch contacts. In addition, the toaster oven shall comply with the tests described in 55.2.5.6, following the endurance test.

60.2.2.5 During the endurance test described above, forced air cooling may be provided to shorten the cool down time, however temperatures obtained adjacent to temperature sensing components or other appropriate reference points shall not exceed those measured during the normal temperature test. During the test a simulated bread load need not be utilized.

Figure 60.1

Simulated toast load



To be constructed to aluminum flashing approximately 0.010 inch (0.254 mm) thick. Outside surface to be painted with minimum 500°F (260°C) flat black engine paint. Total weight to be equal to or less than 25 g without lead shot.

60.2.2.6 A toaster oven and toaster oven/broiler shall be capable of withstanding an endurance test consisting of 6000 cycles of operation of opening and closing the door. During and at the conclusion of the test, the appliance shall meet the following criteria:

a) There shall be no electrical or mechanical malfunction that results in the likelihood of fire, electric shock, or injury to persons;

b) There shall be no loosening or shifting of adjustments or parts that results in the likelihood of fire, electric shock, or injury to persons; and

c) There shall be no failure of applicable switches and contacts.

60.3 Limited short circuit – Motor-control devices

60.3.1 There shall not be any ignition of cotton surrounding the outer enclosure of the protective device (that in some cases, will be the enclosure of the motor that it protects) when three samples of a device controlling a motor are subjected to short circuits on a circuit limited to 200 A.

60.3.2 A motor is considered to comply with the requirement in 60.3.1, if it is equipped with an inherent overheating protector that complies with the requirements for such protectors.

60.3.3 For the tests mentioned in 60.3.1, the power factor of the test circuit is to be 0.9 – 1.0, and the circuit capacity is to be measured without the device in the circuit.

60.3.4 In each case, a nonrenewable cartridge fuse is to be connected in series with the device under test; the fuse is to be of the maximum current rating that will be accommodated by a fuse-holder of the branch circuit to which the appliance would be connected. The test on one sample is to be made by closing the device on the short circuit.

60.4 Toaster supplemental operating control operation time – Cord connected automatic toaster test

60.4.1 In reference to in 22.18, the times measured in 55.2.5.3 shall not be more than the maximum operation time as determined in 60.4.2 plus 60 seconds.

60.4.2 Three samples shall be operated for one cycle with the toaster set to maximum operation time that the toaster can remain energized; maximum darkness plus any additional cycle extending feature such as "Frozen" or "Defrost". The toaster is to be loaded to maximum capacity with slices of commercially available white bread, each weighing approximately 25 g. The test voltage is to be as described in 41.1.14. The time from energization of the toaster elements to when the primary operating control disconnects the ungrounded conductor of the power supply shall be measured. The longest time measured is to be used as the maximum operation time in 22.18.

61 Permanence of Marking

61.1 A required marking shall be molded, die-stamped, paint-stenciled, stamped or etched metal that is permanently secured, or indelibly stamped lettering on a pressure-sensitive label secured by adhesive that upon investigation is found to be acceptable for the application. Ordinary usage (including the likely exposure to weather and other ambient conditions), handling, storage, and the like of the equipment is to be considered in the determination of the acceptability of the application.

61.2 Unless it has been investigated and found to be acceptable for the application, a pressure-sensitive label or label that is secured by cement or adhesive shall comply with the adhesion requirements in Table

7.1 for indoor equipment, and Table 7.2 for outdoor equipment in the Standard for Marking and Labeling Systems, UL 969.

61.3 Unless otherwise indicated, a required cautionary marking shall be located on a part that would require tools for removal or that cannot be removed without impairing the operation of the product.

62 Permanence of Cord Tag

62.1 To determine compliance with 67.25 and 67.27, a cord tag shall:

a) Be either of the following forms, and

1) A flag-type with an adhesive back. The tag is to be wrapped tightly once around and is to adhere to the supply cord. The ends of the tag are to adhere to each other and project as a flag. The required markings are to be positioned on the projecting flag portion of the tag.

2) A flag tag having a hole to permit securement to the power-supply cord by a plastic strap or equivalent means. The strap shall not be removable without cutting.

b) Comply with the following:

1) The Standard for Marking and Labeling Systems – Flag Labels, Flag Tags, Wrap-Around Labels and Related Products, UL 969A, for the cord type it is applied to and to the environmental conditions consistent with the intended use of the product (e.g. indoor use or outdoor use); or

2) Representative samples that have been subjected to the tests described in 62.3 – 62.6, shall meet the following requirements:

i) The tag shall resist tearing for longer than 1/16 inch (1.6 mm) at any point;

ii) The tag shall not separate from the power supply cord;

iii) There shall be no permanent shrinkage, deformation, cracking, or any other condition that renders the marking on the tag illegible; and

iv) Overlamination shall remain in place and not be torn or otherwise damaged. The printing shall remain legible.

62.2 For each type of conditioning mentioned in 62.3 – 62.5, three samples of the tag applied to the power supply cord in the intended manner are to be used. If tags are applied by an adhesive, tests are to be conducted no sooner than 25 hours after application of the tag.

62.3 Three samples are to be tested as received.

62.4 Following conditioning in an air-circulating oven at 60 ±1°C (140 ±1.8°F) for 240 hours, three samples are to be tested after 30 minutes of conditioning at a room temperature of 23 ±2°C (73.4 ±3.6°F) and 50 ±5 percent relative humidity.

62.5 Three samples are to be tested within 1 minute after exposure for 72 hours to a humidity of 85 ±5 percent at 32 ±2°C (89.6 ±6°F).

62.6 Each sample is to consist of a length of power supply cord to which the tag has been applied. The power supply cord, with the attachment plug pointing up, is to be held tautly in a vertical plane. A force of 5 lbf (22.2 N) is to be applied to the upper-most corner of the tag farthest from the power supply cord, within 1/4 inch (6.4 mm) of the vertical edge of the tag. The force is to be applied vertically downward in a

direction parallel to the major axis of the cord. In determining compliance with 62.1(b)(2)(iii), manipulation is permissible, such as straightening of the tag by hand. To determine compliance with 62.1(b)(2)(iv), each sample is to be scraped 10 times across printed areas and edges, with a force of approximately 2 lbf (8.9 N), using the edge of a 5/64 inch (2.0 mm) thick steel blade held at a right angle to the test surface.

63 Small Metal Object Heating Test

63.1 Induction heating elements shall be constructed so that the element can only be operated when a vessel is placed on the cooking zone. The appliance is to be operated at rated voltage with the controls adjusted to their highest setting. An iron bar, 0.08 inches (2 mm) thick having dimensions approximately 3.94 inches x 0.79 inches (100 mm x 20 mm), is to be placed in the most unfavorable position on each cooking zone, tested one at a time. The temperature rise of the bar shall not exceed 35°C (95°F).

MANUFACTURING AND PRODUCTION-LINE TESTS

64 Dielectric Voltage-Withstand Test

64.1 Each appliance shall withstand without an indication of unacceptable performance as a routine production-line test, the application of a potential between the primary wiring, including connected components, and accessible metal parts that are likely to become energized, and between primary wiring and accessible low voltage (42.4 V peak or less) metal parts, including terminals. The test potential shall be 1200 V applied for 1 second or 1000 V applied for 1 minute.

64.2 The appliance may be in a heated or unheated condition for the test.

64.3 The test shall be conducted with the appliance fully assembled. It is not intended that the appliance be unwired, modified, or disassembled for the test.

Exception No. 1: A part, such as a snap cover or a friction-fit knob, that interferes with performance of the test need not be in place.

Exception No. 2: The test may be performed before final assembly if such a test represents testing the complete appliance.

64.4 If the appliance employs a solid-state component that can be damaged by the test potential, the test on each appliance may be conducted before the component is electrically connected. In such a case, additional testing is to be made of a random sampling of each day's production with the circuitry rearranged to reduce the likelihood of damage to any solid-state component but retaining representative dielectric stress of the circuit.

64.5 The test equipment is to produce an output voltage that is not less than the factory test value specified, nor is the magnitude of the test voltage to be greater than 120 percent of the specified test potential when the tester is used in each of the following conditions:

a) If the test duration is one second, the output voltage is to be maintained within the specified range:

1) When only a voltmeter having an input impedance of at least 2 megohms and a specimen of the product being tested are connected to the output terminals; and

2) When a relatively high resistance is connected in parallel with the voltmeter and the product being tested, and the value of the resistance is gradually reduced to the point where an indication of unacceptable performance just occurs.