UL 283

STANDARD FOR SAFETY

Air Fresheners and Deodorizers

UL Standard for Safety for Air Fresheners and Deodorizers, UL 283

Third Edition, Dated June 16, 2015

Summary of Topics

This revision of ANSI/UL 283 dated April 29, 2021 includes the withdrawal and replacement of UL 508C with UL 61800-5-1; 6.5.4.1 and 6.13.4.4

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated February 5, 2021.

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UL 283

Standard for Air Fresheners and Deodorizers

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This ANSI/UL Standard for Safety consists of the Third edition including revisions through April 29, 2021.

The most recent designation of ANSI/UL 283 as an American National Standard (ANSI) occurred on April 29, 2021. 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 UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover household and commercial air fresheners and deodorizers, rated 250 volts or less for use in ordinary locations in accordance with the National Electrical Code, ANSI/NFPA 70.

1.2 These requirements cover air fresheners and deodorizers for deodorizing or scenting air, or both, by the dispersal of chemicals, fragrances, or both. Air fresheners and deodorizers employing heating elements, electronic circuits, motor-operated fans (or a combination thereof), and mechanical filters are also covered by these requirements.

1.3 These requirements are intended to evaluate these appliances with respect to the risk of fire, electric shock, injury to persons, and explosiveness of atmosphere. The physiological effects of the operation of these appliances, beneficial or otherwise, are not covered by this Standard. The assigned ratings do not cover other potential risks, including the physiological effects of these appliances, in any form, nor do they indicate the efficiency or effectiveness of the intended uses of these appliances.

1.4 These requirements do not cover insect-repellent dispensers, air sterilizing appliances, air cleaning products, air filters, room ionizers, smoke scrubbers, or ultraviolet filters.

1.5 These requirements do not cover permanently-connected appliances.

1.6 These requirements do not cover direct plug-in appliances with open reservoirs for the addition of either a liquid or a substance that when heated becomes a liquid.

1.7 Direct plug-in air fresheners and deodorizers provided with illumination shall be additionally evaluated to the Standard for Direct Plug-In Nightlights, UL 1786.

1.8 Electric toys are covered by the Standard for Electric Toys, UL 696.

1.9 Electric toy transformers are covered by the Standard for Toy Transformers, UL 697.

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 AIR DEODORIZER – An appliance that is intended to treat the air in a relatively small area by the dispersal of chemicals, fragrances, or both. Some appliances employ a mechanical filter.

4.3 AIR FRESHENER – An appliance that is intended to scent the air in a relatively small area by the dispersal of chemicals, fragrances, or both. Some appliances employ a mechanical filter.

4.4 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).

4.5 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.

4.6 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.

4.7 APPRECIABLY DEPLETED – A reduction in total consumable volume of greater than 15 percent during operation of the unit over the entire life of the fragrance a stated by the manufacturer.

4.8 ASKAREL – A generic term for a group of nonflammable synthetic chlorinated hydrocarbons used as electrical insulating media. Askarels of various compositional types are used. Under arcing conditions the gases produced, while consisting predominantly of noncombustible hydrogen chloride, can include varying amounts of combustible gases depending upon the askarel type.

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

a) The repeated starting of the appliance, beyond one complete predetermined cycle of operation to the point where some form of limit switch opens the circuit, is independent of any manual control;

b) During any single predetermined cycle of operation, the motor is caused to stop and restart one or more times;

c) Upon energizing the appliance, the initial starting of the motor is capable of being intentionally delayed beyond normal, conventional starting; or

d) During any single predetermined cycle of operation, automatic changing of the mechanical load is capable of reducing the motor speed to the degree required to reestablish starting-winding connections to the supply circuit.

4.10 CHILD-APPEALING FEATURE – A feature that has entertaining audio or visual effects, or that depicts (logos, decals, art work, etc.) or resembles in physical form or function articles commonly recognized as appealing to or intended for use by children under 5 years of age. This includes, but is not limited to, features that depict or resemble cartoon characters, toys, guns, watches, musical instruments, vehicles, toy animals, food or beverages, or that play musical notes or have flashing lights or other entertaining features.

For features that do not depict or resemble the items listed above, the following additional factors will be considered in determining whether a direct plug-in air freshener or deodorizer has a feature that is commonly recognized as one that is designed or intended primarily to provide visual appeal and attraction to children ages 5 and under:

a) The manufacturer’s intent to market the product with visual appeal and attraction to, and with the intent to invite or entice interaction by, children under 5 years of age, as evidenced by a review of any of the following:

1) Product labeling,

2) Product packaging (for example, depictions of the product being used in children’s rooms, or being handled directly by children),

3) Advertising materials,

4) Promotional materials,

5) Other materials accompanying the product,

b) The nature of any designs or depictions on the product, or the nature of the design or the shape of a component of the product, based on a consideration of the following:

1) Whether the designs or depictions, or the design or shape of the component, reflects a seasonal or holiday theme commonly recognized as appealing to adults and commonly recognized as being consistent with trends in the marketplace for seasonally-themed merchandise for the home; or

2) Whether the designs or depictions, or the design or shape of the component, reflects an embellishment or motif that is commonly recognized as appealing primarily to children under the age of 5, and not intended for mass appeal to both adults and children.

4.11 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.

4.12 CONSUMABLE – A substance that is depletable, disposable, or both, in any form that remains or transforms through operation into pellets, gel, or liquid, that either functions in conjunction with an accessory that attaches to the appliance (that is, deodorizer or air freshener), or is directly inserted into the appliance.

4.13 CONTAINER – A receptacle in which the consumable is held or carried during use in the appliance.

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

4.15 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.

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

4.17 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 mitigate the potential hazard, is considered an operating control. Operating controls are also referred to as “regulating controls".

4.18 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. Protective controls are also referred to as “limiting controls” and “safety controls”.

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

4.19 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.

4.20 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.

4.21 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.

4.22 DIRECT PLUG-IN APPLIANCE – An appliance that has integral blades for direct insertion into a receptacle rated either 15 or 20 A, 125 V. Some appliances are provided with a polarized, parallel blade receptacle.

4.23 ENCLOSURE – That part of the appliance that:

a) Renders inaccessible all or any parts of the appliance that present a risk of electric shock or injury to persons due to total or partial collapse with a resulting reduction of spacings, loosening or displacement of parts, or serious defects, or

b) Retards propagation of flame initiated by electrical disturbances occurring within, or

c) Both (a) and (b).

4.24 FAN BLADE – A component of an impeller.

4.25 FLASH POINT – The minimum temperature of a liquid at which vapor is evolved in a large enough quantity to form a flammable mixture with air.

4.26 FRAGRANCE – Any consumable that is designed to produce a vapor that has an odor.

4.27 IMPELLER – An assembly of blades about an integral hub.

4.28 LOW VOLTAGE – Not greater than 30 Vrms or 42.4 V peak or 42.4 V dc.

4.29 MOUNTING MEANS – Hardware to mount the appliance to the building structure or to an outlet box.

4.30 OPERATING TEMPERATURE OF THE FRAGRANCE – The maximum temperature measured on the air freshener and deodorizer appliance in an area that is in direct contact with the vapor generated by the product for a liquid fragrance or at the container body in contact with the appliance for a gel pack.

4.31 PORTABLE APPLIANCE – A direct plug-in appliance or an appliance provided with a power-supply cord for connection to the supply circuit, that is capable of being easily moved by hand from place to place.

4.32 RESERVOIR – A vessel that holds the consumable in the appliance. The reservoir is intended to be refilled by the consumer during use of the appliance.

4.33 RISK OF ELECTRIC SHOCK – A risk of electric shock exists at any part when:

a) The potential between the path and earth ground or any other accessible part is more than 30 V rms (42.4 V peak); and

b) The continuous current flow through a 1500 ohm resistor connected across the potential exceeds 0.5 mA.

4.34 SEAL – A component made of elastomers, composite gasket material, flexible cellular material, thermoplastics, and thermoplastic elastomers that exclude or hold within an enclosure consumables that are liquid, solid, or vapor.

4.35 STATIONARY APPLIANCE – A direct plug-in appliance or an appliance provided with a power-supply cord for connection to the supply circuit, that is intended to be fastened in place or located in a dedicated place.

4.36 USER SERVICING – Any form of servicing, such as routine cleaning and replacement of a fuse, lamp, or a consumable, that is performed by personnel other than those trained to maintain the appliance.

CONSTRUCTION

5 General

5.1 An appliance shall employ materials that are intended for the application.

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

6 Components

6.1 General

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

a) Comply with the requirements for that component as indicated in 6.2 – 6.22 or the individual component section;

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

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

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

e) Not contain mercury.

Note: Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

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, or

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 UL component standard other than those cited in 6.2 – 6.22 is acceptable if:

a) The component also complies with the applicable component standard of 6.2 – 6.22 or the individual component section; or

b) The component standard:

1) Is compatible with the ampacity and overcurrent protection requirements NFPA 70, where appropriate;

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

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

6.1.2 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(s) that cover devices that provide those functions.

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

6.1.3 A component not anticipated by the requirements of this standard, not specifically covered by the component standards of 6.2 – 6.22 or individual component sections and that involves a potential risk of electric shock, fire, or personal injury, shall be additionally investigated in accordance with the applicable UL standard, and shall comply with 6.1.1 (b) – (d).

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

6.2 Attachment plugs, receptacles, connectors, and terminals

6.2.1 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. See 6.2.8.

Exception: Attachment plugs and appliance couplers integral to cord sets or power supply cords are covered under the requirements of UL 817 and need not comply with UL 498.

6.2.2 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.

6.2.3 Single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment, and that are intended for factory assembly to copper or copper alloy conductors, or for factory assembly to printed wiring boards, shall comply with the Standard for Component Connectors for Use in Data, Signal, Control and Power Applications, UL 1977. See 6.2.8.

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

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

6.2.6 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.

6.2.7 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059.

6.2.8 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.

6.3 Batteries and battery chargers

6.3.1 A lithium ion (Li-On) single cell battery shall comply with the requirements for secondary lithium cells in the Standard for Lithium Batteries, UL 1642. A lithium ion multiple cell battery, and a lithium ion battery pack, shall comply with the applicable requirements for secondary lithium cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

6.3.2 Rechargeable nickel cadmium (Ni-Cad) cells and battery packs shall comply with the applicable construction and performance requirements of this end product standard.

6.3.3 Rechargeable nickel metal-hydride (Ni-MH) battery cells and packs shall comply with construction and performance requirements of this end product standard, or the applicable requirements for secondary cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

6.3.4 Primary batteries (non-rechargeable) that comply with the relevant UL standard and 6.1 are considered to fulfill the requirements of this Standard.

6.3.5 A Class 2 battery charger shall comply with one of the following:

a) The Standard for Class 2 Power Units, UL 1310; or

b) The Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, with an output marked "Class 2", or that complies with the limited power source (LPS) requirements and is marked "LPS".

6.3.6 A non-Class 2 battery charger shall comply with one of the following:

a) The Standard for Power Units Other Than Class 2, UL 1012; or

b) The Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1.

6.4 Capacitors and filters

6.4.1 The component requirements for a capacitor are not specified. A capacitor complying with the Standard for Capacitors, UL 810, is considered to fulfill the requirements of 16.1.

6.4.2 Electromagnetic interference filters with integral enclosures that comply with the Standard for Electromagnetic Interference Filters, UL 1283, are considered to fulfill the requirements of 16.1.

6.5 Controls

6.5.1 General

6.5.1.1 Auxiliary controls shall be evaluated using the applicable requirements of this end product standard and the parameters in Section 24, Controls – End Product Test Parameters.

6.5.1.2 Operating (regulating) controls shall be evaluated using the applicable component standard requirements specified in 6.5.2 – 6.5.7, and if applicable, the parameters in Section 24, Controls – End Product Test Parameters, unless otherwise specified in this end product standard.

6.5.1.3 Operating controls that rely upon software for the normal operation of the end product where deviation or drift of the control may result in a hazard, such as a speed control unexpectedly changing its output, shall comply with:

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

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

6.5.1.4 Protective (limiting) controls shall be evaluated using the applicable component standard requirements specified in 6.5.2 – 6.5.7, and if applicable, the parameters in Section 24, Controls – End Product Test Parameters, unless otherwise specified in this end product standard.

6.5.1.5 Solid-state protective controls that do not rely upon software as a protective component shall comply with:

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

b) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, except 11.2 h) (Controls using software).

6.5.1.6 Protective controls that rely upon software as a protective component shall comply with:

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

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

6.5.1.7 An electronic, non-protective control that is simple in design need only be subjected to the applicable requirements of this end-product standard. A control that does not include an integrated circuit or microprocessor, but does consist of a discrete switching device, capacitors, transistors, and resistors, is considered simple in design. See Section 48, Abnormal Operation Test.

6.5.2 Electromechanical and electronic controls

6.5.2.1 A control, other than as specified in 6.5.3 – 6.5.7, shall comply with:

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

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

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

6.5.3 Liquid level controls

6.5.3.1 A liquid level control shall comply with:

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

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

c) The Standard for Industrial Control Equipment, UL 508; or

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

1) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Water Level Controls of the Float Type for Household and Similar Applications, UL 60730-2-16A; or

2) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Water and Air Flow Sensing Controls, Including Mechanical Requirements, UL 60730-2-18.

6.5.4 Motor and speed controls

6.5.4.1 A control used to start, stop, regulate or control the speed of a motor shall comply with:

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

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

c) The Standard for Industrial Control Equipment, UL 508; or

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

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

6.5.5 Pressure controls

6.5.5.1 A pressure control shall comply with one of the following:

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

b) The Standard for Industrial Control Equipment, UL 508; or

c) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements, UL 60730-2-6.

6.5.6 Temperature controls

6.5.6.1 A temperature control shall comply with:

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

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

c) The Standard for Industrial Control Equipment, UL 508; or

d) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9.

6.5.7 Timer controls

6.5.7.1 A timer control shall comply with:

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

b) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Timers and Time Switches, UL 60730-2-7.

6.6 Cords, cables, and internal wiring

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

6.6.2 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.

6.6.3 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;

c) The Standard for Fixture Wire, UL 66; or

d) The appropriate UL standard (s) for other insulated conductor types specified in Chapter 3 (Wiring Methods and Materials) of 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 or personal injury need not comply with UL 758.

6.7 Film-coated wire (magnet wire)

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

6.7.2 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.

6.8 Gaskets and seals

6.8.1 Gaskets and seals that comply with the Standard for Gaskets and Seals, UL 157, are considered to fulfill the requirements of 9.2 and 62.

6.9 Heaters and heating elements

6.9.1 Electric resistance heating elements shall comply with the construction requirements of:

a) The Standard for Electric Heating Appliances, UL 499; or

b) The Standard for Sheathed Heating Elements, UL 1030.

Exception: 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.

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

6.10 Insulation systems

6.10.1 Materials used in a Class 105 (A) insulation system shall comply with Section 33, Insulation Systems.

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

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

6.11 Light sources and associated components

6.11.1 Lampholders and indicating lamps shall comply with the Standard for Lampholders, UL 496.

Exception: Lampholders forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

6.11.2 Lighting ballasts shall comply with:

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

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

Exception No. 1: Ballasts forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

Exception No. 2: Ballasts for other light sources shall comply with the appropriate UL standard(s).

6.11.3 Light emitting diode (LED) light sources shall comply with the Standard for Light Emitting Diode (LED) Equipment For Use In Lighting Products, UL 8750.

Exception No. 1: LED light sources forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

Exception No. 2: Individual LED light sources mounted on printed wiring boards and intended for indicating purposes need not comply with UL 8750, but shall comply with the applicable requirements of this end product standard.

6.12 Marking and labeling systems

6.12.1 A marking and labeling system shall comply with the Standard for Marking and Labeling Systems, UL 969 under the specified environmental conditions.

Exception: A marking or labeling system that complies with Section 50, Permanence of Marking Test, of this standard is considered to fulfill the requirement.

6.13 Motors and motor overload protection

6.13.1 General

6.13.1.1 General-purpose type motors having a NEMA frame size shall comply with the requirements specified in 6.13.2. This includes fractional HP motors rated up to 1 HP (typically NEMA frame sizes 42, 48, or 56), and integral HP motors rated 1 HP and greater (typically NEMA frame sizes 140 – 449T).

6.13.1.2 Motors not enclosed, or partially enclosed, by the end product enclosure shall comply with the requirements specified in 6.13.2.

6.13.1.3 Component type motors completely enclosed within the end product enclosure shall comply with the requirements specified in 6.13.2 or 6.13.3.

6.13.1.4 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.

6.13.1.5 Low voltage component fans that comply with the Standard for Electric Fans, UL 507, are considered to fulfill the requirements of Section 20, Motors.

6.13.2 General-purpose type motors

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

6.13.3 Component type motors

6.13.3.1 Component type motors shall comply with either 6.13.3.2 or 6.13.3.3.

6.13.3.2 The motor shall comply with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1 except as noted in Table 6.1.

Table 6.1
Superseded requirements

UL 1004-1 Exempted Requirement	Superseded by UL 283 Requirements
Current and Horsepower Relation, Section 6	20.3.4
Cord-Connected Motors, Section 15	11.1
Factory Wiring Terminals and Leads, Section 17	Section 14
Electrical Insulation, Section 22	Section 13
Non-Metallic Functional Parts, Section 28	Sections 7, 13, 20
Solid-State Controls, 7.2	Section 6.5
Non-metallic enclosure thermal aging, 9.1.4	7.2.8
Motor enclosure, 9.2 – 9.4	Section 7
Grounding, Sections 10 and 11	Section 17
Ventilation Openings, Section 12: only applicable where the openings are on surfaces considered to be the appliance enclosure	7.2.8
Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts, Section 13	Section 10
Protection Against Corrosion, Section 14	Section 9
Available fault current ratings for motor start and running capacitors, Clause 26.6: not applicable for cord and plug connected appliances.	Section 16
Switch, Section 27 is not applicable to centrifugal starting switches	Section 23
With the exception of Sections 35 and 40 (Resilient Elastomer Mounting and Electrolytic Capacitor Tests, respectively), the performance tests of UL 1004-1 are not applicable	All applicable performance tests.
Only the following marking requirements specified in 43.1 of UL 1004-1 are applicable: manufacturer's name or identification; rated voltage; rated frequency; number of phases if greater than 1; and multi-speed motors, other than a shaded-pole or a permanent-split-capacitor motor, shall be marked with the amperes and horsepower at each speed	72.1

6.13.3.3 The motor shall comply with the applicable component requirements in Section 6, the following construction requirements, and the applicable performance requirements (when tested in conjunction with the end product), of this end product standard:

a) Protection against corrosion, Section 9;

b) Insulating Material, Section 13;

c) Internal wiring, Section 14;

d) Capacitors, Section 16;

e) Grounding, Section 17;

f) Motors, Section 20;

g) Spacings, Section 25.

6.13.4 Motor overload protection

6.13.4.1 Thermal protection devices integral with the motor shall comply with:

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

b) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2 Particular Requirements for 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).

6.13.4.2 Impedance protection shall comply with the Standard for Impedance Protected Motors, UL 1004-2.

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

6.13.4.4 Except as indicated in 6.13.4.3, electronically protected motor circuits shall comply with one of the following. See 6.5.4 for basic control requirements.

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; or

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

c) 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 casualty hazard during abnormal testing with the motor electronic circuit rendered ineffective; compliance with the applicable requirements of this end product standard is then required.

6.14 Overcurrent protection

6.14.1 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. UL 248-5). Defined use fuses that comply with UL 248-1 and another appropriate UL standard for the fuse are considered to fulfill this requirement.

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

6.14.3 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.

6.14.4 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.

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

6.14.6 Fusing resistors shall comply with the Standard for Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances, UL 1412.

6.15 Polymeric materials and enclosures

6.15.1 Unless otherwise specified in this end product standard, polymeric electrical insulating materials and enclosures shall comply with the applicable requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

6.15.2 Metallized or painted polymeric parts or enclosures shall comply with the applicable requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. This requirement is not applicable to exterior surfaces of polymeric enclosure materials or parts provided that the metallized coating or paint does not offer a continuous path for an internal flame to propagate externally.

6.16 Power supplies

6.16.1 A Class 2 power supply shall comply with one of the following:

a) The Standard for Class 2 Power Units, UL 1310; or

b) The Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, with an output marked "Class 2", or that complies with the limited power source (LPS) requirements and is marked "LPS".

6.16.2 A non-Class 2 power supply shall comply with one of the following:

a) The Standard for Power Units Other Than Class 2, UL 1012; or

b) The Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1.

6.17 Printed-wiring boards

6.17.1 Printed-wiring boards, including the coatings, shall comply with the Standard for Printed-Wiring Boards, UL 796.

Exception: A printed-wiring board in a Class 2 nonsafety circuit is not required to comply with the bonding requirements in UL 796 if the board is separated from parts of other circuits such that loosening of the bond between the foil conductor and the base material will not result in the foil conductors or components coming in contact with parts of other circuits of the control or of the end-use product.

6.18 Semiconductors and small electronic components

6.18.1 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with the Standard for Electrically Isolated Semiconductor Devices, UL 1557. The dielectric voltage withstand tests required by UL 1557 shall be conducted applying the criteria of Section 41 of this end product standard.

6.18.2 An optical isolator that is relied upon to provide isolation between primary and secondary circuits or between other circuits as required by this end product standard shall comply with the Standard for Optical Isolators, UL 1577. The dielectric voltage withstand tests required by UL 1577 shall be conducted applying the criteria of Section 41 of this end product standard.

6.18.3 Except as specified in 6.18.4, component requirements are not specified for small electronic components on printed wiring boards, including diodes, transistors, resistors, inductors, integrated circuits, and capacitors not directly connected to the supply source.

6.18.4 Where an electronic component is determined to be a critical component during the testing of Section 48, Abnormal Operation Test, one of the following standards shall be applied. See 24.4 of this end product standard for the test parameters to be used.

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, including its Follow-Up Program; and as applicable, the Standard for Software in Programmable Components, UL 1998 for controls that rely upon software as a protective component; or

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

6.18.5 A critical component is a component that performs one or more safety-related functions whose failure results in a condition, such as the risk of fire, electric shock, or injury to persons, in the end product application.

6.18.6 A critical component may also be identified using a failure-mode and effect analysis (FMEA) in accordance with the Failure-Mode and Effect Analysis (FMEA) section of UL 991.

6.18.7 Portions of a circuit comprised of a microcontroller or other programmable device that performs a back-up, limiting, or other safety function intended to reduce the risk of fire, electric shock, or injury to persons shall comply with the Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1, Annex H.

6.19 Supplemental insulation, insulating bushings, and assembly aids

6.19.1 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill 14.2.5 or a performance requirement of this standard. In such cases:

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

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

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

6.19.2 Wire positioning devices shall comply with Sections 13 and 15. A device that complies with the Standard for Positioning Devices, UL 1565, is considered to fulfill this requirement.

6.19.3 Insulating bushings that comply with Section 6.1 of this end product standard, and the Standard for Insulating Bushings, UL 635, are considered to fulfill the requirements of this Standard. 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.

6.20 Switches

6.20.1 Switches shall comply with one of the following, as applicable:

a) The Standard for Special-Use Switches, UL 1054;

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

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

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

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

6.20.2 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 Clock-Operated Switches, UL 917; or

b) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Timers and Time Switches, UL 60730-2-7.

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

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

b) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Timers and Time Switches, UL 60730-2-7.

6.20.4 A timer or time switch, incorporating electronic timing circuits or switching circuits, with or without separable contacts, that functions as a protective control, shall comply with the requirements for a protective control; see 6.5.1.4.

6.21 Transformers

6.21.1 A transformer shall comply with the construction and performance requirements in the following Standards:

a) The Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2;

b) The Standard for Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411; or

c) The Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

6.22 Valves (electrically operated) and solenoids

6.22.1 Electrically operated valves shall comply with:

a) The Standard for Electrically Operated Valves, UL 429; or

b) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Electrically Operated Water Valves, Including Mechanical Requirements, UL 60730-2-8.

6.22.2 Solenoids shall comply with the applicable construction and performance requirements of this end-product standard.

7 Frame and Enclosure

7.1 General

7.1.1 An appliance shall be formed and assembled so that it will have the strength and rigidity required to resist the abuses to which it is able to be subjected, without increasing the risk of fire, electric shock or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

7.1.2 For unreinforced, flat surfaces in general, cast metal shall not be less than 1/8 in (3.2 mm) thick, except that malleable iron not less than 2.4 mm (3/32 in) and die cast metal not less than 2.0 mm (5/64 in) thick each meet the intent of the requirement. Corresponding thicknesses of not less than 2.4 mm (3/32 in), 1.6 mm (1/16 in), and 1.2 mm (3/64 in), respectively, are able to be used when the surface under consideration is curved, ribbed, or otherwise reinforced, or when the shape or size, or both, of the surface is such that the required mechanical strength is provided.

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

7.1.4 A non-metallic enclosure shall comply with the applicable mechanical and electrical property considerations, flammability, and thermal requirements as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. A force as detailed in Table 61.1 shall apply to the appliance when determining the impact resistance of polymeric enclosures.

Exception No. 1: A polymeric grille used in a fan is not required to comply with the flammability requirements of UL 746C when:

a) The material has a minimum flame class rating of HB;

b) It is used as an enclosure of insulated current-carrying parts and the insulation thickness is 0.71 mm (0.028 in) or greater; and

c) The grille is completely external when installed as intended.

Exception No. 2: A polymeric grille used in a fan intended to be mounted at least 2.1 m (7 ft) above the floor is not required to comply with the Resistance to Impact Test of UL 746C.

7.1.5 Among the factors that shall be taken into consideration when judging a nonmetallic enclosure or an enclosure of magnesium are resistance to:

a) Mechanical damage;

b) Impact;

c) Moisture-absorption;

d) Combustion;

e) Distortion at temperatures to which the material is able to be subjected under conditions of normal or abnormal use; and

f) Resistance to arcing.

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

7.1.7 The requirements in 7.1.6 necessitate the use of a barrier or material having a zero flame spread rating when tested as described in the Standard for Tests for Surface Burning Characteristics of Building Materials, UL 723:

a) Under a motor unless:

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

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

i) Open main winding;

ii) Open starting winding;

iii) Starting switch short-circuited; and

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

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

Exception: A direct drive fan motor is required to only be subjected to the locked rotor test.

4) The motor complies with the requirements in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, and the temperature of the motor winding does not exceed 150° C during the first 72 hours of operation with the rotor of the motor locked.

b) Under the wire, unless the wire:

1) Is thermoplastic insulated, such as wire marked VW-1; or

2) Has at least equivalent characteristics as determined in the flame tests specified in the Standard for Thermoplastic-Insulated Wires and Cables, UL 83.

c) Under a switch, relay, solenoid, or similar component unless:

1) A short circuit or overload in the component does not result in a risk of fire; or

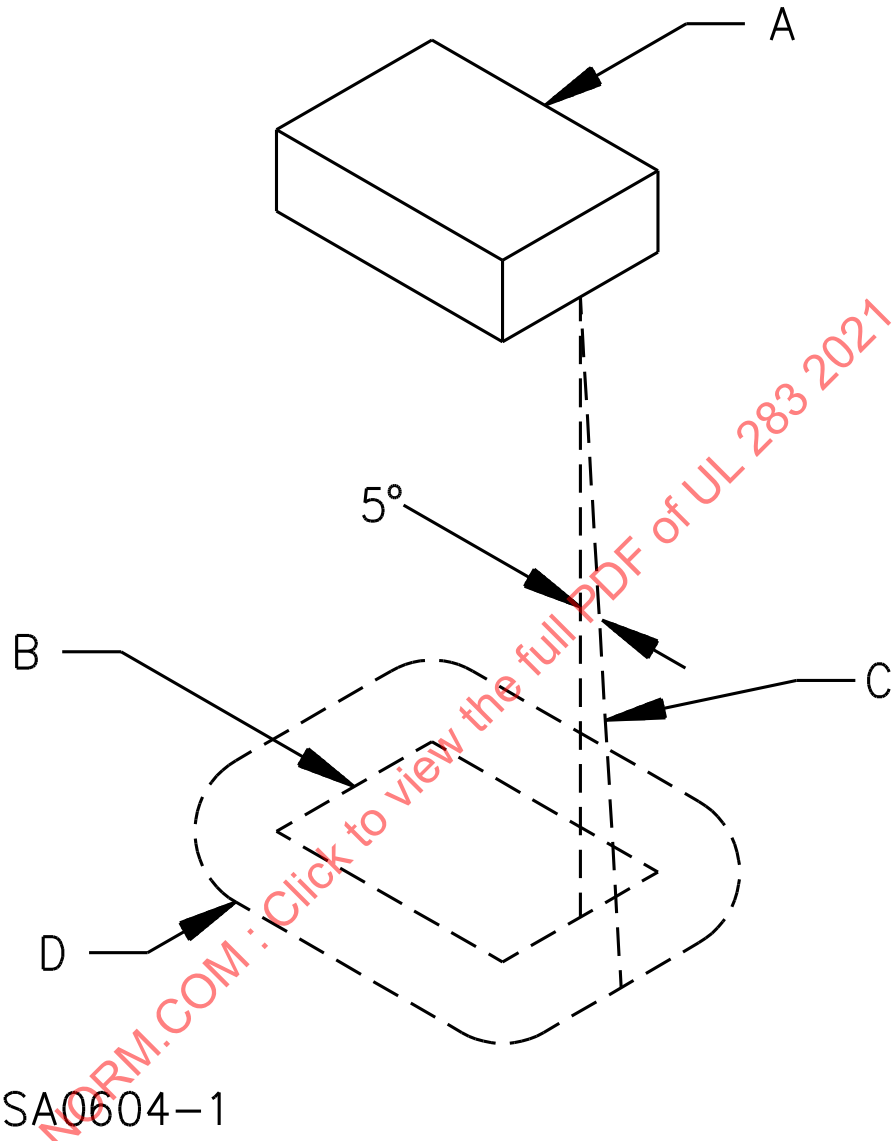
2) There are no openings in the enclosure through which molten metal, burning insulation, flaming particles, or other ignited material can fall.

Exception: A terminal is not required to have a barrier.

7.1.8 The barrier mentioned in 7.1.7 shall be horizontal, shall be located as illustrated in Figure 7.1, and shall not have an area less than that described in the figure. The use of openings for drainage, ventilation, and similar purposes in the barrier meets the intent of the requirement, when molten metal, burning insulation, or other ignited material are not able to come into contact with combustible material through these openings.

Figure 7.1

Location and extent of barrier



NOTES –

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

B – Projection of outline of component on horizontal plane.

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

1) tangent to the component;

2) 5 degrees from the vertical; and

3) oriented so that the area traced out on a horizontal plane is maximum.

D – Location (horizontal) and minimum area for barrier. The area is that included inside the line of intersection traced out by the inclined line C and the horizontal plane of the barrier.

7.1.9 The enclosure of an air freshener or deodorizer shall be such as to reduce the risk of liquid from contacting uninsulated current-carrying parts when the appliance is tested as described in the Flooding of Current-Carrying Parts Test, Section 42, as applicable.

7.1.10 A door or a cover of an enclosure that provides access to any overload protective device that requires resetting or renewal shall be hinged or otherwise attached in an equivalent manner. If the opening of such a door or cover exposes the user to accessible current-carrying parts, other than the screw shell or clips of a fuseholder, the door or cover shall not be capable of being opened without the use of a tool.

7.1.11 Means shall be provided for holding the door or cover over a fuseholder in a closed position. The door or cover shall be tight-fitting, and shall not be capable of being opened without the use of a tool if the opening of such a door or cover exposes the user to accessible current-carrying parts other than the screw shell or clips.

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

7.1.13 To determine whether an appliance complies with the requirement in 7.1.12, any part of the enclosure or barrier that is able to be removed without the use of tools to gain access to the hanging means is to be removed.

7.1.14 An opening in the appliance provided for hanging shall be located or guarded so that a nail, hook, or similar fasteners do not displace a part that creates a risk of fire or electric shock, and does not contact one of the following:

a) An uninsulated current-carrying part.

b) Magnet wire.

c) Internal wiring.

d) Moving parts.

e) Any other part able to create a risk of fire or electric shock.

7.1.15 An enclosure, frame, guard, handle, or other part of the appliance that is exposed to contact during intended operation shall not be sharp enough to constitute a risk of injury to persons, as determined by the Standard for Tests for Sharpness of Edges on Equipment, UL 1439.

7.1.16 An accessible liquid coating material (such as paint, enamel, lacquer, ink, and the like) applied to a direct plug-in Deodorizer or Air Fresheners with child appealing features shall not contain compounds of lead, antimony, arsenic, barium, cadmium, chromium, mercury, or selenium exceeding amounts specified in the Standard Consumer Safety Specification for Toy Safety, ASTM F963. A liquid coating material is considered to be accessible if it can be contacted by persons before or after compliance with the performance requirements described the Impact test Section 61 and Mold Stress-Relief Distoration Test Section 59.

Exception: The requirements for a liquid coating material do not apply to ink applied to a packing material.

7.2 Non-metallic parts other than enclosures

7.2.1 The material of a reservoir, the breakage of which is capable of resulting in risk of fire or electric shock, shall have such properties as to meet the conditions anticipated in use.

7.2.2 A reservoir, when installed in the appliance as directed by the manufacturer's instructions, shall withstand the applicable requirements in the Impact Test, Section 61, without cracking, breaking, or sustaining other damage that causes leaking of the liquid it is intended to contain.

Exception: Current-carrying parts are not required to be so located or protected from unintended exposure to the liquid contained in the reservoir if the reservoir:

a) Is resistant to deterioration from the liquid intended for use in it, as determined by the Resistance to Deterioration Test, Section 62; and

b) Complies with the requirement in the Impact Test, Section 61.

7.2.3 Polymeric material used to enclose a metal housing that encloses insulated or uninsulated current-carrying parts, or used as a decorative part, shall be classed either 5VA, 5VB, V-0, V-1, V-2, or HB by the burning tests described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception No. 1: Decorative parts are not required to be made of a material classed 5VA, 5VB, V-0, V-1, V-2, or HB when the part does not occupy a volume greater than 2 cm^3 (0.122 in^3), does not have any dimension greater than 3 cm (1.18 in), and is located so it does not propagate flame from one area to another or bridge between a possible source of ignition and other ignitable parts.

Exception No. 2: A material is determined to be equivalent when it complies with the 12-mm (0.47-in) flame test, the 19-mm (0.75-in) flame test, or 127-mm (5-in) flame test of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, when flame tested as used in the equipment. A flame-retardant coating applied to the inside of a polymeric enclosure shall not be used unless the coating/material interface is determined to be equivalent by separate investigation.

7.2.4 An impeller of polymeric material outside a motor shall not be located within 25.4 mm (1 in) of an opening in the motor housing.

Exception: An impeller is not prohibited from being within 25.4 mm of an opening in the motor housing when:

a) The material is classed as V-2, V-1, V-0, 5VA, or 5VB in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94; or

b) The material complies with the requirements for enclosure flammability using a 19-mm (3/4-in) flame, in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C; or

c) No motor opening within 25.4 mm of the blade has a dimension more than 6.75 mm (17/64 in) or an area more than 35.48 mm^2 (0.055 in^2), and no more than six such openings are provided; or

d) In a skeleton or open frame type motor:

1) The impeller is of material classed HB or less flammable in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94;

2) The coil is completely wrapped with insulation at least 0.8 mm (1/32 in) thick; and

3) The space between the coil wrap and bobbin does not exceed 0.8 mm; or

e) The material has a hot wire ignition rating of at least 7 seconds as described in the Standard Test Method for Ignition of Materials by Hot Wire Sources, ASTM D3874; or

f) The appliance employs a thermally protected motor to drive the impeller and complies with the Impeller Ignition Test, Section 54.

7.2.5 Foamed thermoplastic shall be classed HF-2 or HF-1.

7.2.6 A thermoplastic part that is not decorative and that does not serve as an enclosure shall be classed HB, 5VA, 5VB, V-2, V-1, or V-0.

Exception No. 1: The requirement of 7.2.6 does not apply to wicks.

Exception No. 2: A flammability class is not required for a reservoir if the test specimens neither flame nor glow when subject to the Glow Wire Test of the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, at a temperature of 550°C. Flaming or glowing of the test specimen is acceptable if it extinguishes within 30 seconds after removal of the glow wire and there is no ignition of the tissue paper beneath the test specimen.

7.2.7 Thermoplastic gel pack materials shall comply with one of the following:

a) Classed minimum HB; or

b) Shall not flame nor glow when subjected to the Glow Wire Test of the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, at a temperature of 550° C. Flaming or glowing of the test specimen is acceptable if it extinguishes within 30 seconds after removal of the glow wire and there is no ignition of the tissue paper beneath the test specimen.

Exception: This requirement does not apply to the membrane of the gel pack.

7.2.8 The polymeric housing of a component is not considered to be an appliance enclosure unless this part is the sole insulation (excluding air) between a live part and an external surface of the appliance.

8 Mechanical Assembly

8.1 An appliance shall be assembled so that the vibration of normal operation does not adversely affect it. Brush caps shall be tightly threaded or otherwise constructed to reduce the risk of loosening.

8.2 A switch other than a through-cord switch, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or similar component shall be securely mounted and shall be kept from turning. See 8.4.

Exception No. 1: A switch is not required to be kept from turning when:

a) The switch:

1) Is of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during normal operation of the switch; and

2) The means for mounting the switch greatly reduces the probability that operation of the switch will loosen it.

OR

b) The switch:

1) Rotates and spacings are not reduced below the minimum required values; and

2) The normal operation of the switch is by mechanical means rather than by direct contact by persons.

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

8.3 Uninsulated current-carrying parts shall be secured to the base or mounting surface so that they are restricted from turning or shifting in position, if such motion results in a reduction of spacings below the minimum required values.

8.4 The means for keeping the switch and current-carrying parts mentioned in 8.2 and 8.3 from turning or shifting is to consist of more than friction between surfaces. For example, a properly applied lock washer employed to keep a small stem-mounted switch (or other device having a single-hole mounting means) from turning meets the intent of the requirement.

9 Protection Against Corrosion

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

Exception No. 1: Surfaces of sheet-steel and cast-iron parts within an enclosure are not required to be protected against corrosion if the oxidation of the metal due to the exposure to air and moisture is not appreciable. The thickness of metal and temperature are also to be taken into account as part of such a decision.

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

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

10 Accessibility of Uninsulated Current-Carrying Parts, Film-Coated Wire, and Moving Parts

10.1 To reduce the risk of electric shock from unintentional contact with an uninsulated current-carrying part or film-coated wire, or injury to persons from a moving part, an opening in an enclosure shall comply with either (a) or (b).

a) For an opening that has a minor dimension (see 10.5) less than 25.4 mm (1 in), such a part or wire shall not be contacted by the probe illustrated in Figure 10.1.

b) For an opening that has a minor dimension of 25.4 mm (1 in) or more, such a part or wire shall be spaced from the opening as specified in Table 10.1.

Exception: A motor, other than one used in either a hand-held appliance or a hand-supported portion of an appliance, is not required to comply with these requirements if it complies with the requirements in 10.2.

Figure 10.1

Articulate probe with web stop

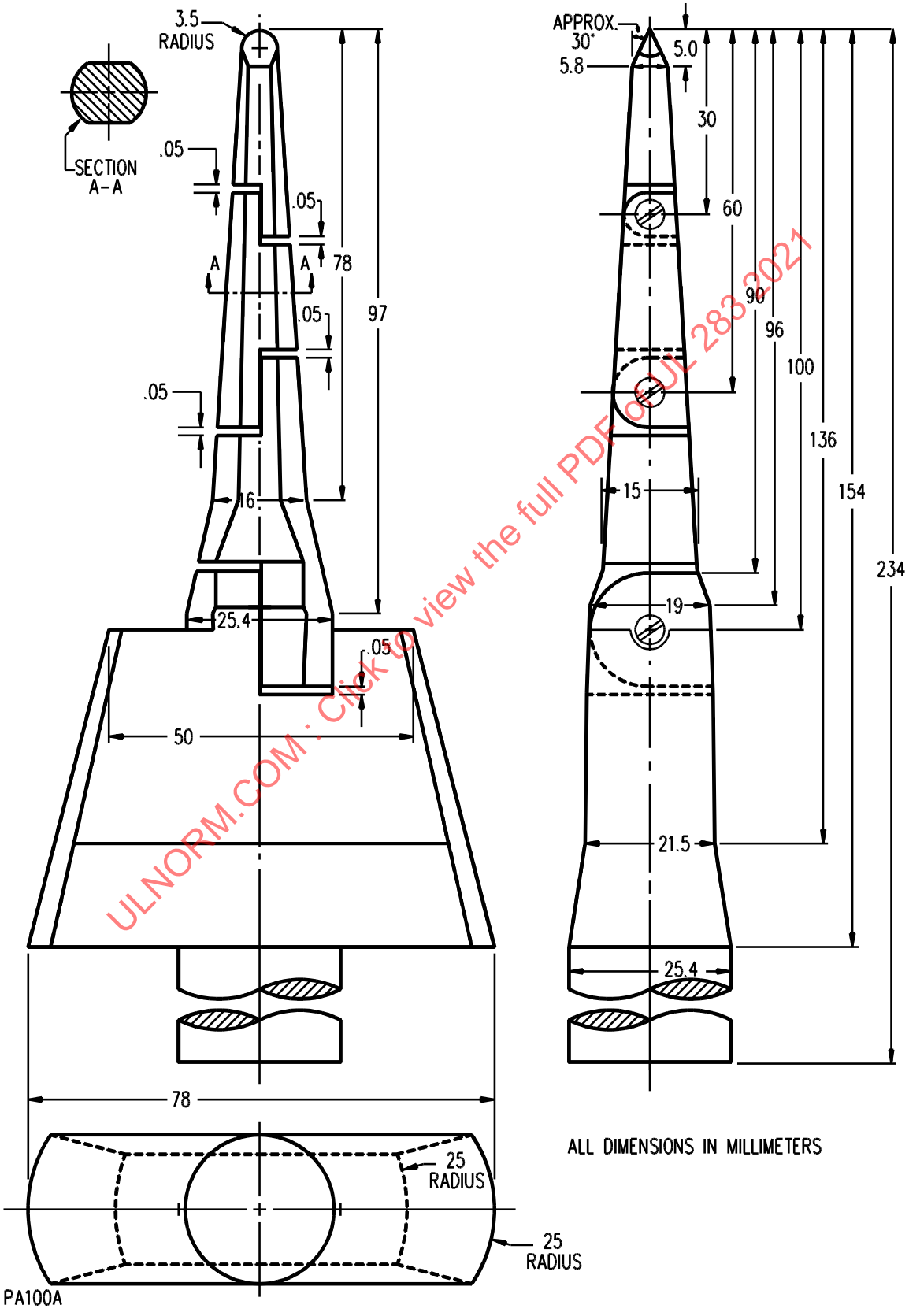


Table 10.1
Minimum distance from an opening to a part that involves a risk of electric shock

Minimum dimension[a] of opening,		Minimum distance from opening to part,	
mm[b]	(in)	mm[b]	(in)
19.1	(3/4)[c]	114	(4-1/2)
25.4	(1)[c]	165	(6-1/2)
31.8	(1-1/4)	190	(7-1/2)
38.1	(1-1/2)	318	(12-1/2)
47.5	(1-7/8)	394	(15-1/2)
54.0	(2-1/8)	444	(17-1/2)
d		762	(30)

[a] See 10.5.

[b] Between 19 and 54 mm (3/4 and 2-1/8 in), interpolation is to be used to determine a value between values specified in the table.

[c] Any dimension less than 1 inch applies to a motor only.

[d] More than 54 mm (2-1/8 in) but not more than 152 mm (6 in).

10.2 With respect to a part or wire as mentioned in 10.1, in an integral enclosure of a motor as mentioned in the exception to 10.1:

a) An opening that has a minor dimension (see 10.5) less than 19.1 mm (3/4 in) meets the intent of the requirement if:

1) A moving part is unable to be contacted by the probe illustrated in Figure 10.1;

2) Film-coated wire is unable to be contacted by the probe illustrated in Figure 10.3;

3) In a directly accessible motor (see 10.6), an uninsulated current-carrying part is unable to be contacted by the probe illustrated in Figure 10.4; and

4) In an indirectly accessible motor (see 10.6), an uninsulated current-carrying part is unable to be contacted by the probe illustrated in Figure 10.2.

b) An opening that has a minor dimension of 19.1 mm (3/4 in) or more meets the intent of the requirement if a part or wire is spaced from the opening as specified in Table 10.1.

Figure 10.2

Probe for moving parts and uninsulated current-carrying parts

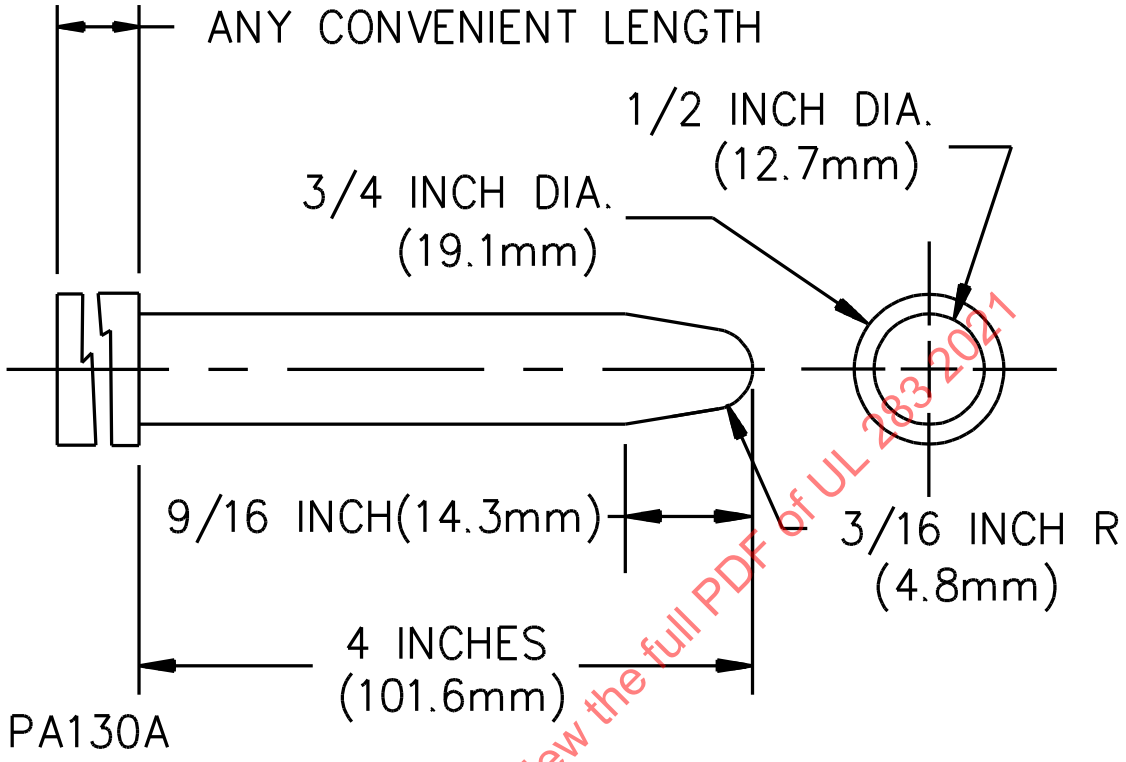


Figure 10.3

Probe for film-coated wire

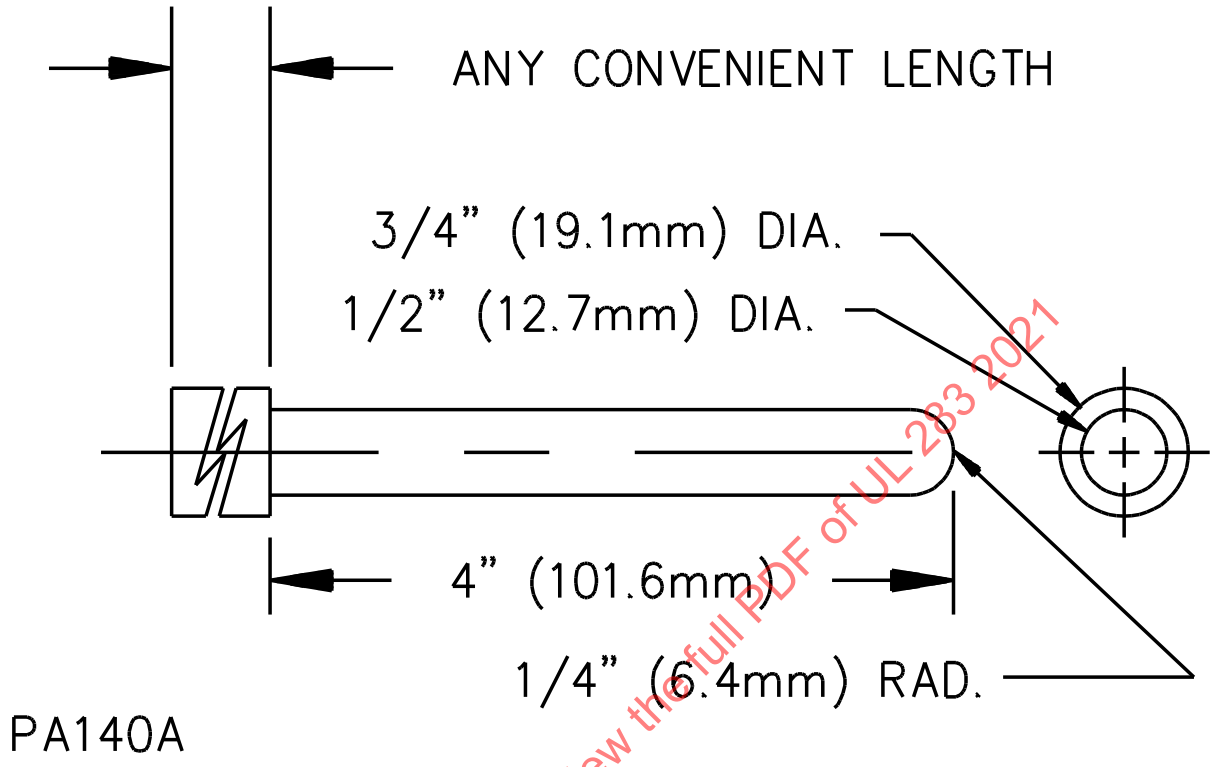
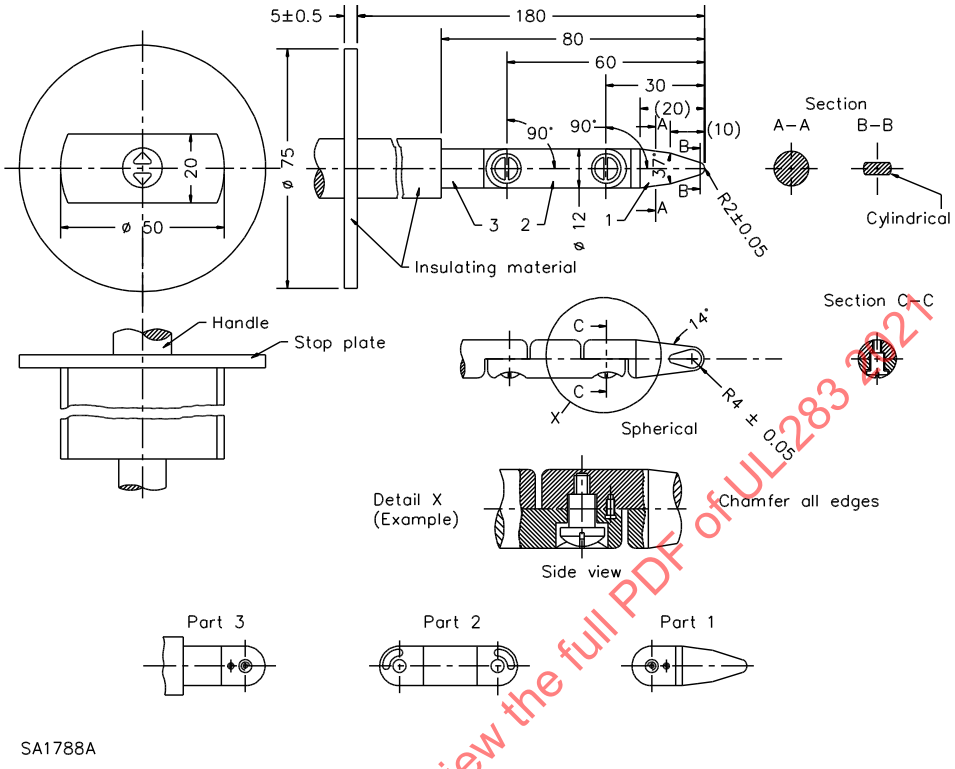


Figure 10.4

IEC articulate probe



10.3 The probes mentioned in 10.1 and 10.2 and illustrated in Figure 10.1 – Figure 10.4 shall be applied to any depth achievable within the opening, and shall be rotated or angled before, during, and after insertion through the opening to any position, as required, in order to examine the enclosure.

10.4 The probes mentioned in 10.3 and 10.5 shall be used as measuring instruments to judge the accessibility provided by an opening, and not as instruments to judge the strength of a material; they shall be applied with the minimum force intended to determine accessibility.

10.5 With reference to the requirements in 10.1 and 10.2, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that is able to be inserted through the opening.

10.6 With reference to the requirements in 10.2, an indirectly accessible motor is a motor that is accessible only by opening or removing a part of the outer enclosure, such as a guard or panel, that is able to be opened or removed without using a tool, or that is located at such a height or is otherwise guarded or enclosed so that contact does not occur. A directly accessible motor is a motor that can be contacted without opening or removing any part or that is located so as to be accessible to contact.

10.7 During the examination of an appliance to determine whether it complies with the requirements in 10.1 or 10.2, a part of the enclosure that is able to be opened or removed by the user without a tool (that is, to attach an accessory, to make an operating adjustment, or for other reasons) is to be opened or removed.

10.8 With reference to the requirements in 10.1 and 10.2, insulated brush caps are not required to be additionally enclosed.

11 Supply Connections

11.1 Cord-connected appliances

11.1.1 Cords and plugs

11.1.1.1 A cord-connected appliance shall be provided with a length of attached flexible cord and an attachment plug for connection to the supply circuit, in accordance with Table 11.1 or of a type equally serviceable for the application, or shall have male pin terminals that accommodate a detachable power-supply cord. The length of a detachable power-supply cord, when provided with an appliance, shall be in accordance with Table 11.1. The length of cord external to the appliance shall be measured from the face of the attachment plug to the point of attachment or entry into the enclosure.

Table 11.1
Cords for appliances

Appliance	Type of cord	Length, m (ft)
1. Motor-operated appliance type not intended to rest directly on floor when in use.	SP-1, SPT-1	1.5 – 3.0 (5 – 10)
2. Motor-operated appliance type that rests directly on floor when in use.	SP-2, SPT-2	1.5 – 3.0 (5 – 10)
3. Portable appliance employing a general-use convenience receptacle	SJ, SJE, SJO, SJT, SJTO, or equivalent	0.5 – 7.6 (1.5 – 25)
4. Counter-top or table-top heater type appliance intended for household use.	HPD, HPN, HSJ, HSJO, SP-2, SPE-2, SPT-2, SV, SVO, SVE, SVOO, SVT, SVTO, SVTOO, SJ, SJO, SJE, SJOO, SJT, SJTO, or SJTOO [b]	0.6 – 2.1 (2.0 – 7.0) [a]
5. All heater-type appliances not covered from above.	[See item 4]	1.8 (6.0)
[a] See 72.2.2 when cord length is less than 1.4 m (4.5 ft).		
[b] SP-1 or SPT-1 permitted for appliances weighing 227 g (0.5 lbs) or less.		

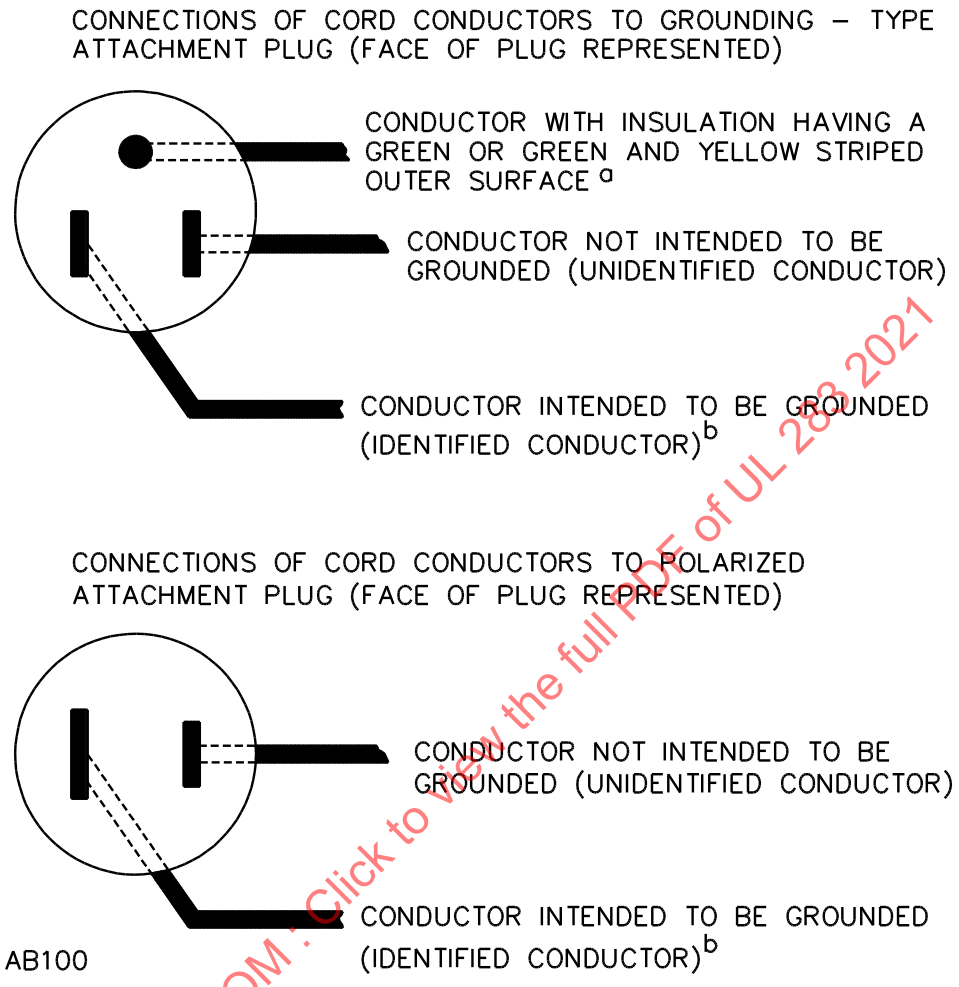
11.1.1.2 The flexible cord shall have a voltage rating not less than the rated voltage of the appliance, and shall have an ampacity that is not less than the current rating of the appliance.

11.1.1.3 The attachment plug shall have an ampacity not less than the rated current of the appliance, or the input current under maximum normal load conditions, whichever is greater, and a voltage rating equal to the rated voltage of the appliance.

11.1.1.4 The attachment plug of an appliance intended to be connected to a nominal 120 volt circuit, and employing devices required to be connected to a specific supply conductor as specified in 19.2 and 23.3 shall be a polarized type. The connections to the attachment plug shall be in accordance with Figure 11.1. The polarity identification of the supply cord shall be in accordance with Table 11.2. See 72.2.1.

Figure 11.1

Connections to attachment plugs



NOTES –

[a] In the above illustration, connection of the green conductor to a blade which has a U-shape instead of a circular cross section meets the intent of the requirement.

[b] Signifies a conductor identified in accordance with Table 11.2.

Table 11.2
Polarity identification of flexible cords

Method of identification	Acceptable conditions	
	Wire intended to be grounded[a] – wire to be connected to the screw shells of lampholders	**All other wires[a]**
Color of braids on individual conductors	Solid white or grey – without tracer	Solid color other than white or grey – without tracer
	Color other than white, or grey, with tracer in braid	Solid color other than white or grey – without tracer
Color of insulation on individual conductors	Solid white or grey[b]	Solid color other than white or grey
	Light blue[c]	Solid color other than light blue, white or grey
Color of separators	White or grey[c]	Color other than white, or grey
Other means	Tin or other white metal on all strands of the conductor[d]	No tin or other white metal on the strands of the conductor
	A stripe, ridge, or groove on the exterior surface of the cord[d]	

[a] A wire finished to show a green color with or without one or more yellow stripes or tracers is to be used only as an equipment-grounding conductor. See 17.2.1 and Figure 11.1.

[b] Only for cords (other than types SP-1, SP-2, SPT-1, or SPT-2) having no braid on any individual conductor.

[c] For jacketed cords.

[d] Only for types SP-1, SP-2, SPT-1, and SPT-2 cords.

11.1.1.5 An appliance that is required to employ a polarized attachment plug as specified in 11.1.1.4, and that is provided with a separate or detachable cord set as specified in 11.1.1.6, shall also employ an appliance connector of the polarized type.

11.1.1.6 A household appliance intended for use with a detachable cord set shall not be provided with terminal pins that accommodate an appliance plug.

11.1.2 Strain relief

11.1.2.1 Strain relief shall be provided so that the mechanical stress on the flexible cord is not transmitted to terminals, splices, or internal wiring. See 47.1.

11.1.2.2 A metal strain-relief clamp or metal band is capable of being used without supplementary protection on a Type SJ, SJO, SJT, SJTO, S, SO, ST, STO, SV, or SVO cord.

11.1.2.3 A metal strain-relief clamp or metal band shall not be used on Type SP-2 or lighter rubber-insulated cord or on Type SPT-1, SPT-2, SVT, or SVTO cord unless such a cord is protected by varnished cloth tubing or the equivalent under the clamp, and the construction complies with the requirements specified in 47.4.

11.1.2.4 Means shall be provided to inhibit the supply cord or lead from being pushed into the enclosure of an appliance through the cord-entry hole when such displacement results in:

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.

To determine compliance, the supply cord or lead shall be tested in accordance with the Push Back Relief Test, Section 63.

11.1.2.5 When a knot in a flexible cord serves as the strain relief, the surfaces that the knot touches shall be free from projections, sharp edges, burrs, fins, or similar edges that damage the conductors.

11.1.3 Bushings

11.1.3.1 A bushing or the equivalent shall be provided at a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case. The bushing shall be substantial, secured in place, and shall have a smooth, well-rounded surface which is capable of handling for incidental contact against the cord without damage to the cord. An insulating bushing shall be provided when:

a) The cord is Type SP-1, SPT-1, SP-2, or SPT-2, or other type lighter than Type SV;

b) The wall or barrier is of metal; and

c) The construction is such that the cord is subjected to stress or motion.

Exception: For a cord hole in wood, porcelain, phenolic composition, or other nonconductive material, a smoothly rounded surface is the equivalent of a bushing.

11.1.3.2 Ceramic materials and some molded compositions are capable of being used as insulating bushings.

11.1.3.3 Vulcanized fiber is a usable alternative material not prohibited from being employed when the bushing is not less than 1.2 mm (3/64 in) thick and when formed and secured in place so that it is not damaged by conditions of ordinary moisture. To determine if this type of bushing is capable of being damaged by ordinary moisture, it is to be subjected to the Humidity Conditioning Test, Section 38.

11.1.3.4 A separate soft-rubber, neoprene, or polyvinyl chloride bushing is usable in an appliance, or in the frame of a motor, or in the enclosure of a capacitor attached to a motor of an evaporative cooler, or a room-type filter unit if the bushing is:

a) Not less than 1.2 mm (3/64 in) thick; and

b) Located so that it is not exposed to oil, grease, oily vapor, or other substances that deteriorate the compound employed.

11.1.3.5 A bushing of a material mentioned in 11.1.3.4 shall not be employed in an appliance unless used in conjunction with a type of cord for which an insulating bushing is not required.

11.1.3.6 When a bushing of a material mentioned in 11.1.3.4 is used, the hole in which the bushing is mounted shall be smooth and free from sharp edges.

11.1.3.7 A bushing comprised of the same material as, and molded integrally with, the supply cord is usable on a Type SP-1 or heavier cord, only when the built-up section is not less than 1.6 mm (1/16 in) thick at the point where the cord passes through the enclosure.

11.1.3.8 An insulated metal grommet is capable of being used in place of an insulating bushing when the insulating material is not less than 0.8 mm (1/32 in) thick and completely fills the space between the grommet and the metal in which it is mounted.

11.2 Direct plug-in type appliances

11.2.1 Size and weight

11.2.1.1 When evaluated in accordance with 11.2.1.2 – 11.2.1.3, an air-freshener or deodorizer having integral blades for direct insertion into a receptacle shall comply with the specifications in Table 11.3.

Table 11.3
Size and weight specifications for direct plug-in type appliance

Algebraic quantity	Maximum acceptable value	
W	794 g	(28 oz)
WY/Z	1361 g	(48 oz)
WY/S	1361 g	(48 oz)
WX	0.56 N·m	(80 oz-in)

In this table the variables are defined as follows:

W = the weight of the direct plug-in type appliance in g (oz) as measured on a scale or balance.

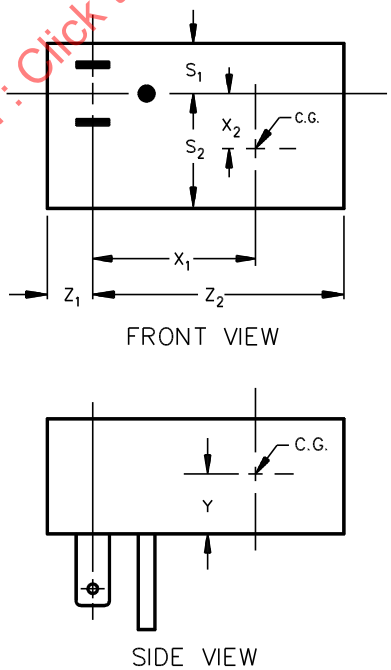
Y = the distance, in mm (in), illustrated in Figure 11.2.

Z = the shorter distance, in mm (in), of Z1 or Z2 illustrated in Figure 11.2.

S = the shorter distance, in mm (in), of S1 or S2 illustrated in Figure 11.2.

X = the longer distance, in mm (in), of X1 or X2 illustrated in Figure 11.2.

Figure 11.2
Dimensions of a typical direct plug-in type appliance



11.2.1.2 The limits specified in Table 11.3 shall be determined as follows:

a) A directly-mounted accessory is to be in place.

b) A removable part is to be in place.

c) A mounting tab is not to be included in the measurement of linear dimensions for the purpose of determining moments unless:

1) There is no deformation of the tab and enclosure after being subjected to the impact described in the Impact Test, Section 61, and

2) For a polymeric-enclosed, direct plug-in type appliance having an integral tab, no distortion shall occur at temperatures that the polymeric material encounters under conditions of normal and abnormal use, as determined by subjecting the direct plug-in type appliance to the Mold Stress-Relief Distortion Test, Section 59.

11.2.1.3 When inserted in a duplex receptacle, no part of a direct plug-in type appliance shall interfere with full insertion of an attachment plug, with dimensions as indicated by Figure 11.5, into the adjacent receptacle. See Figure 11.3 and Figure 11.4. Compliance shall be determined with the duplex receptacle in both the vertical and horizontal orientations unless otherwise specified in the user instructions. Consideration shall be given to the orientation of the ground pin (above and below blades) for products which are grounded. A product is considered to comply if, in at least one orientation, the adjacent receptacle is completely open.

Figure 11.3

125V, 15A Duplex receptacle

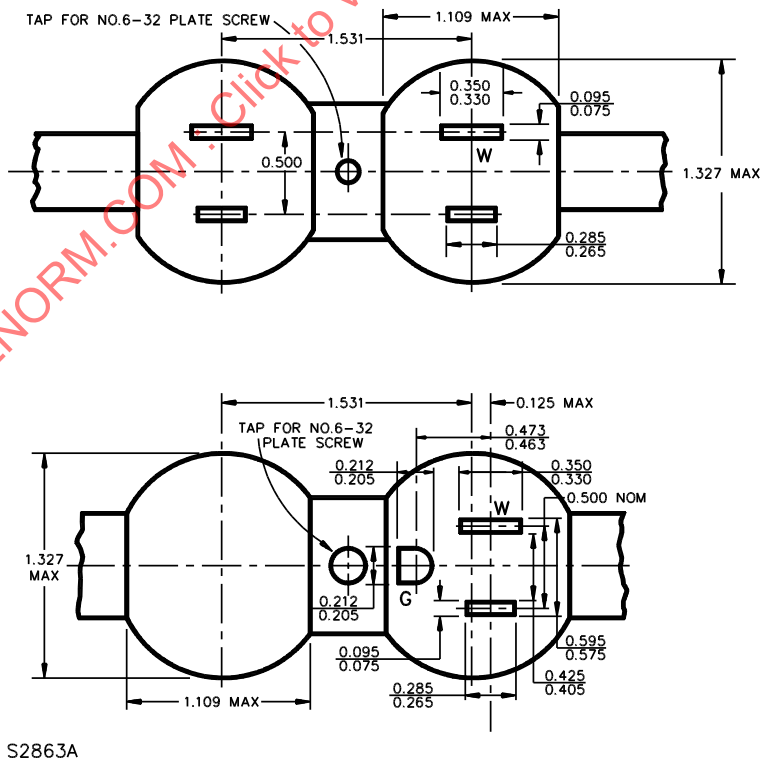


Figure 11.4

250V, 15A Duplex receptacle

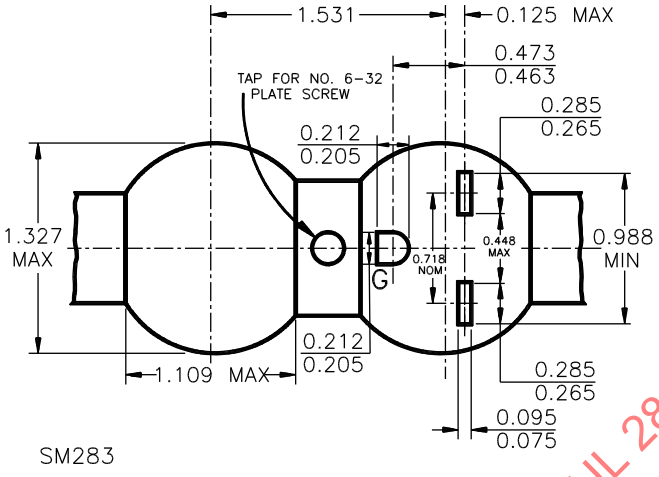
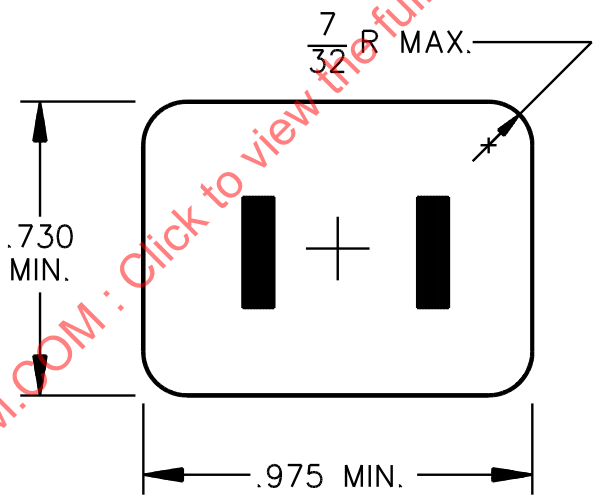


Figure 11.5

Plug face dimensions



mm	5.6	18.54	24.8
(in)	(7/32)	(0.730)	(0.975)

11.2.2 Face size

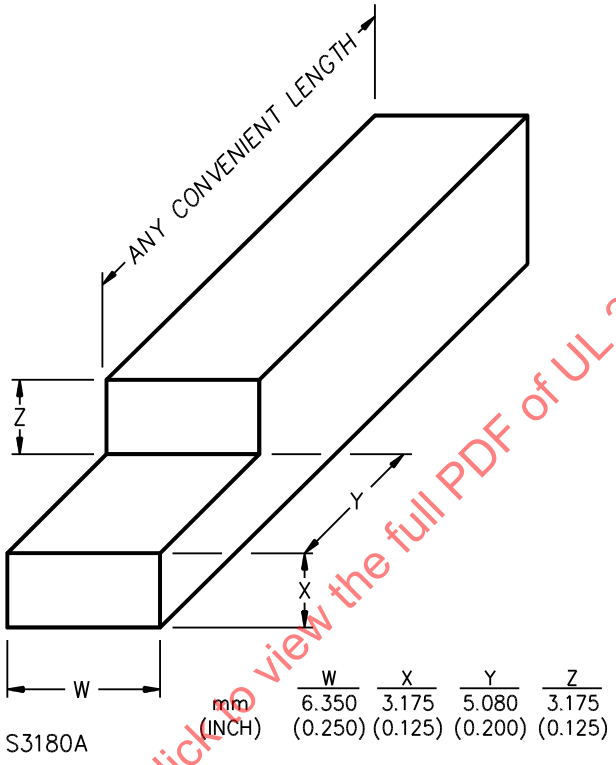
11.2.2.1 The face of a direct plug-in type appliance that contains parallel blades shall have dimensions equal to or greater than those indicated in Figure 11.5.

Exception: A device employing a smaller face size complies with the intent of the requirement when the probe shown in Figure 11.6 does not make contact with the line blades when applied around the

circumference of the device face. The "z" dimension is to be applied against the outside edge of the device face with the "y" dimension perpendicular to the blades.

Figure 11.6

Minimum face size probe



	W	X	Y	Z
mm	6.350	3.175	5.080	3.175
(INCH)	(0.250)	(0.125)	(0.200)	(0.125)

11.2.2.2 A direct plug-in appliance, where the orientation of the parallel blades is able to be rotated by the user, is to be subjected to the Endurance Test, Section 57, and the Torque Test, Section 58, with mechanical stops to prevent full rotation.

12 Current-Carrying Parts

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

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

Exception: Ordinary iron or steel provided with a corrosion-resistant coating is capable of being used for a current-carrying part if determined to be acceptable in accordance with 9.1 or within a motor

13 Insulating Material

13.1 Insulating material employed in an appliance is to be judged with respect to its usability in the particular application. Materials such as mica and certain refractory materials are capable of being used as the sole support of current-carrying parts. Other materials not intended for general use, such as magnesium oxide, are capable of being used in conjunction with other insulating materials, when so located and protected such that the risk of mechanical damage and the absorption of moisture are reduced. When a material is investigated to determine its fitness as an insulator, the key factors to be

examined are its mechanical strength, dielectric-properties, insulation resistance, heat-resistant qualities, the degree to which it is enclosed or protected, and any other features pertinent to the risk of fire, electric shock, or injury to persons involved, in conjunction with conditions of service. All these factors are to be investigated with respect to thermal aging. Polymeric materials shall comply with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

13.2 Vulcanized fiber is capable of being used for an insulating bushing, washer, separator, or barrier but shall not be used as sole support for uninsulated current-carrying parts.

13.3 A molded part shall have mechanical strength and rigidity to withstand the stresses of intended service. Brush caps shall be secured or located so as to be protected from mechanical damage that occurs during intended use.

14 Internal Wiring – Electrical Connections

14.1 Mechanical protection

14.1.1 Wiring and connections between parts of an appliance shall be protected or enclosed.

Exception: A length of flexible cord is capable of being used for external connections if flexibility is essential.

14.1.2 Wires within an enclosure, a compartment, a raceway, or similar structures shall be routed or otherwise protected so that damage to conductor insulation is unable to result from contact with any rough, sharp, or moving part.

14.1.3 A hole through which insulated wires pass in a sheet-metal wall within the overall enclosure of an appliance shall be provided with a smooth, rounded bushing or shall have smooth, rounded surfaces upon which the wires may bear. A flexible cord used for external interconnection, as mentioned in 14.1.1, shall be provided with strain relief and bushings in accordance with the requirements in 11.1.2.1 – 11.1.3.8, and the Strain-Relief Test, Section 47, unless the construction is such that the cord will be protected from stress and motion.

14.1.4 Insulated wires that are bunched and subsequently passed through a single opening in a metal wall within the enclosure of an appliance shall not introduce the risk of fire, electric shock, or injury to persons.

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

14.1.6 Internal wiring shall consist of wires of a type or types that are rated for the application, with respect to temperature, voltage, and conditions of service, such as exposure to oil or grease, associated with normal use.

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

14.1.8 With regard to exposure of insulated wiring through an opening in the enclosure of an appliance, the protection of such wiring, as required by 14.1.1, is determined to exist when the wiring meets the intent of the requirements in 10.1 and 10.2. Internal wiring not so protected is capable of being used when it is secured within the enclosure so that it is not exposed to stress or mechanical damage.

14.2 Splices and connections

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

14.2.2 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 is not maintained.

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

14.2.4 With reference to the requirements in 14.2.3, a wire-binding screw or a pressure wire connector used as a terminating device shall be capable of being used with aluminum under the conditions involved (for example, temperature, heat cycling, and vibration).

14.2.5 Insulation, consisting of two layers of friction tape, two layers of thermoplastic tape, or one layer of friction tape on top of one layer of rubber tape, is capable of being used on a splice if the voltage involved is less than 250 volts. An evaluation of its dielectric properties, heat resistance, moisture resistance and similar performance factors is required in determining if splice insulation consisting of coated-fabric, thermoplastic or other type of tubing meets the intent of the requirement. Thermoplastic tape shall not be wrapped over a sharp edge.

14.2.6 If stranded internal wiring is connected to a wire-binding screw, loose strands of wire shall be secured in such a way as to avoid contact with other uninsulated current-carrying parts that are not always of the same polarity as the wire, and to avoid contact with dead metal parts. This is accomplished by use of pressure terminal connectors, soldering lugs, crimped eyelets, soldering all strands of the wire together, or other consistent means.

15 Separation of Circuits

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

15.2 An insulated conductor shall be securely retained so that it is unable to contact an uninsulated current-carrying part of a circuit operating at a different potential

16 Capacitors

16.1 A capacitor provided as a part of a capacitor motor and a capacitor connected across the line, such as a capacitor for radio-interference elimination or power-factor correction, shall be housed within an enclosure or container that will protect the plates against mechanical damage and that will reduce the risk of the emission of flame or molten material resulting from malfunction or breakdown of the capacitor. The container shall be of metal providing strength and protection not less than that of uncoated steel having a thickness of 0.51 mm (0.020 in). Sheet metal having a thickness less than 0.66 mm (0.026 in) is not recommended.

Exception: The individual container of a capacitor consisting of sheet metal less than 0.51 mm (0.020 in) thick or material other than metal still meets the intent of the requirement, if the capacitor is mounted in an enclosure that houses other parts of the appliance and the enclosure is intended to house current-carrying parts.

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

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

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

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

17 Grounding

17.1 General

17.1.1 An appliance intended to be used on a circuit operating at a potential of more than 150 volts to ground shall have provision for grounding, or shall be provided with a double insulation system that complies with the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097.

17.1.2 With reference to 17.1.1, a two-wire appliance intended to operate at any potential higher than 150 volts to ground, shall be provided with means for grounding in accordance with 17.1.5 and 17.1.6, unless the marked rating on the appliance is 120/240 volts or the appliance is otherwise marked to indicate that it is to be connected to a circuit operating at 150 volts or less to ground.

17.1.3 An appliance marked as double-insulated shall not be provided with a means for grounding.

17.1.4 If a grounding means is provided, whether required or not, it shall be in accordance with 17.1.5 and, if the appliance is cord-connected, shall comply with the requirements in 17.1.6. All exposed dead metal parts, and all dead metal parts within the enclosure that are exposed to contact during any user servicing operation, that are capable of becoming energized shall be securely connected to the means for grounding.

17.1.5 In a cord-connected appliance, grounding shall consist of an equipment grounding conductor in the cord.

17.1.6 The grounding conductor of a supply cord shall be secured to the frame or enclosure of the appliance by means of a screw that is not intended to be removed during any servicing operation not involving the power-supply cord, or by other equivalent means. Solder alone shall not be used for securing the grounding conductor. Servicing includes repair of the appliance by qualified service personnel.

17.1.7 The grounding conductor of a cord-connected appliance shall be connected to the grounding member of an attachment plug. The grounding member shall be fixed.

17.1.8 A separable connection, such as that provided by an attachment plug and a mating connector or receptacle, shall be such that the equipment-grounding connection is made before connection to (and broken after disconnection from) the supply conductors.

Exception: Interlocked plugs, receptacles, and connectors that are not energized when the equipment-grounding connection is made or broken meet the intent of the requirement.

17.1.9 If an appliance is intended to be grounded and is provided with means for separate connection to more than one power supply, each such connection shall be provided with a means for grounding.

17.1.10 A terminal solely for the connection of an equipment-grounding conductor shall be capable of securing a conductor of the size required for the application. A connection device that depends on solder alone shall not be provided for connecting the equipment-grounding conductor.

17.1.11 A wire-binding screw or pressure wire connector intended for the connection of an equipment-grounding conductor shall be located so that it is not to be removed during normal servicing of the appliance.

17.2 Grounding identification

17.2.1 The surface of the insulation of a grounding conductor of a flexible cord shall be green with or without one or more yellow stripes.

17.2.2 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 so identified.

18 Heating Elements

18.1 A heating element shall be protected against mechanical damage.

18.2 A heating element shall be supported such that sagging, loosening, and other adverse conditions resulting from continuous heating do not result in a risk of fire or electric shock.

18.3 An open-wire element, such as uninsulated resistance wire, may be used in heating appliances provided it is enclosed or protected by barriers or covers which require tools for removal, and it complies with the requirements for accessibility of electrical parts specified in Accessibility of Uninsulated Current-Carrying Parts, Film-Coated Wire, and Moving Parts, Section 10.

18.4 A sheathed heating element used in air or immersed in liquid shall comply with 6.9.

19 Lampholders

19.1 A lampholder for a low-voltage lamp (for example, a 6-volt lamp) shall not be tapped across a part of a winding of a motor if the motor is rated more than 230 volts.

19.2 The screw shell of an Edison-base lampholder in an appliance equipped with a polarized attachment plug, shall be connected to the terminal or lead that is intended to be connected to the grounded conductor of the power-supply circuit.

20 Motors

20.1 Construction

20.1.1 A motor shall be rated for the application, and shall be capable of handling the maximum normal load of the appliance as described in 40.1.9 and 40.1.10 without creating a risk of fire, electric shock, or injury to persons.

20.1.2 A motor winding shall resist the absorption of moisture, as evaluated by the Humidity Conditioning Test, Section 38.

20.1.3 With reference to the requirement in 20.1.2, film-coated wire is not required to be additionally treated to resist absorption of moisture, but fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials are to be provided with impregnation or otherwise treated to resist moisture absorption.

20.1.4 The diameter of a motor is the diameter of the circle circumscribing the stator frame measured in the plane of the laminations, excluding lugs, fins, boxes, and similar structures, used solely for motor mounting, cooling, assembly, or connection.

20.2 Brush wear out

20.2.1 A brush-holder assembly shall be constructed so that when a brush is worn out (no longer capable of performing its function), the brush, spring, and other parts of the assembly shall be retained to the degree required so as not to cause accessible dead metal parts to become energized, and current-carrying parts to become accessible.

20.3 Overload protection

20.3.1 Motors shall incorporate thermal or overload protection in accordance with 20.3.2 when the appliance is intended to be remotely or automatically controlled.

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

a) Thermal protection complying with the applicable requirements in the Standard for Thermally Protected Motors, UL 1004-3.

Exception No. 1: The duration of the temperature test and endurance test, both under locked-rotor conditions, is not required to comply with the Standard for Thermally Protected Motors, UL 1004-3:

1) When an appliance includes a control, such as a timer, that positively and reliably limits the length of time the appliance is able to operate, a shorter test duration for the locked-rotor temperature and locked-rotor endurance tests meets the intent of the requirement. For this construction, the duration of these tests shall not be less than the time to which the control limits appliance operation.

2) When the time to operate a manually reset protective device through 10 cycles of operation is longer than the time the appliance is intended to be operated during each use, conducting less than 10 cycles of operation of the device for the locked-rotor temperature test meets the intent of the requirement. For this construction, the number of cycles shall be 4 cycles or the number of cycles required for maximum intended operating time of the appliance, whichever is longer.

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

Exception No. 3: A shaded-pole motor with a 2:1 or smaller ratio between locked-rotor and no-load currents, and a 1-ampere or smaller difference between no-load and locked-rotor currents, is determined to have overload protection that meets the intent of these requirements when it is protected against locked-rotor conditions only.

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

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

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

a) Comply with requirements in 20.3.2, or

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

20.3.4 If a requirement in this Standard refers to the horsepower rating of a motor and the motor is not rated in horsepower, Table 20.1 and Table 20.2 are to be used which give the relationships between horsepower and full-load currents for motors. For a universal motor, the table applying to a single-phase, alternating-current motor is to be used if the appliance is marked for use on alternating current only; otherwise, the table applying to direct-current motors is to be used.

Table 20.1
Full-load motor-running currents in amperes corresponding to various a-c horsepower ratings

Horsepower	110 – 120 V			220[a] – 240 V		
	Single phase	Two phase	Three phase	Single phase	Two phase	Three phase
1/10	3.0	–	–	1.5	–	–
1/8	3.8	–	–	1.9	–	–
1/6	4.4	–	–	2.2	–	–
1/4	5.8	–	–	2.9	–	–
1/3	7.2	–	–	3.6	–	–
1/2	9.8	4.0	4.0	4.9	2.0	2.0
3/4	13.8	4.8	5.6	6.9	2.4	2.8

[a] To obtain full-load currents for 208 V motors, increase corresponding 220 – 240 V ratings by 10 percent for single-phase motors.

Table 20.2
Full-load motor-running currents in amperes corresponding to various d-c horsepower ratings

Horsepower	110 – 120 V	220 – 240 V
1/10	2.0	1.0
1/8	2.2	1.1
1/6	2.4	1.2
1/4	2.9	1.5
1/3	3.6	1.8
1/2	5.2	2.6
3/4	7.4	3.7

20.3.5 For a multispeed motor of any of the types mentioned in 20.3.1 that employs a separate overload protective device to provide running overload protection, the requirement applies at all speeds at which the motor is intended to operate.

20.3.6 The motor of an appliance with load characteristics that result in an overload or stalled condition not evident to the user shall incorporate thermal or overload protection in accordance with the requirements in 20.3.2.

20.3.7 The functioning of a motor-protective device provided as part of an appliance, whether such a device is required or not, shall not result in a risk of fire, electric shock, or injury to persons.

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

20.3.9 Fuses employed for motor-running overload protection shall be located in each ungrounded conductor.

20.3.10 With reference to 20.3.2(c), an overload-protective device conforming to the National Electrical Code, NFPA 70, is equivalent to an overload device that is responsive to motor current and is rated or set as specified in column A of Table 20.3. When the rating of the motor-running overload protection determined in accordance with the foregoing does not correspond to a standard size or rating of a fuse, nonadjustable circuit breaker, thermal cutout, thermal relay, or heating element of a thermal-trip motor switch, the next higher size, rating, or setting shall be used, and shall not be more than that specified in column B of Table 20.3. For a multispeed motor, each winding connection is to be considered separately.

Table 20.3
Maximum rating or setting of overload-protective device

Type of motor	Ampere rating of device as a percentage of motor full-load current rating	
	A	B
Motor with marked service factor of 1.15 or more	125	140
Motor with marked temperature rise of 40°C or less	125	140
Any other motor	115	130

20.3.11 Overload protection in which contacts control a relay coil in a motor starter shall comply with the requirements in 20.3.2.

21 Overload- or Thermal-Protective Devices

21.1 An overload- or thermal-protective device shall have a current and voltage rating not less than the load that it controls.

21.2 A protective device that requires resetting or replacement after it opens shall be readily accessible.

Exception: The protective device is not required to be readily accessible under the following conditions:

a) The appliance, with the protective device shunted out of the circuit, complies with all applicable requirements in this Standard; and

b) The presence of the protective device that is ordinarily unknown to the user of the appliance because of its location and the omission of reference to the device in the operating instructions, circuit diagrams, and required documents for the appliance.

21.3 A protective device shall be wholly inaccessible from outside the appliance without opening a door or cover.

Exception: The operating handle of a circuit breaker, the operating button of a manually operable motor protector, or similar parts projecting outside the appliance enclosure comply with the intent of the requirement.

21.4 A fuseholder shall be constructed and installed so that no uninsulated current-carrying part other than clips is exposed to contact by persons removing or replacing fuses.

Exception: The requirement does not apply if the presence of the protective device is ordinarily unknown to the user of the appliance because of its location and the omission of reference to the device in the operating instructions, circuit diagrams, and other required documents for the appliance.

21.5 The screw shell of a plug-type fuseholder and the cap end of an extractor post-type fuseholder shall be connected towards the load.

21.6 A protective device shall not open the circuit during intended operation of the appliance.

22 Receptacles

22.1 If an appliance is supplied with a receptacle, the receptacle shall comply with the applicable requirements in 6.2, and/or the Standard for Current Taps and Adapters, UL 498A.

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

22.3 A general purpose receptacle rated for use on a nominal 120 volt circuit shall be of a polarized type. The grounded supply conductor shall be connected to the terminal that is substantially white in color or otherwise marked to indicate that it is intended for connection to the grounded supply conductor.

22.4 An appliance employing a receptacle that has a fuse intended to be replaced in the field shall be marked as specified in 72.1.11.

23 Switches and Controls

23.1 A switch or other control device shall have a current and voltage rating not less than that of the load that it controls.

23.2 With reference to the requirement in 23.1, the current rating of a switch that controls an inductive load other than a motor, such as a transformer, shall not be less than twice the rated full-load current of the transformer unless the switch has been evaluated for the application.

23.3 In an appliance rated 125 or 125/250 volts (3-wire) or less, a switch or an overcurrent-protective device of the single pole type, other than an automatic control without a marked off position, shall be electrically connected to a terminal or lead intended for connection to an ungrounded conductor of the supply circuit, unless there are no current-carrying parts exposed to unintentional contact when the switch is open or unless the fact that such parts carry current is definitely apparent.

23.4 A manually operated motor-control switch shall be provided in a cord-connected appliance that employs a motor rated more than 1/3 horsepower (250 W output).

23.5 A switch that controls a medium-base lampholder of other than a pilot or indicating light shall function with tungsten-filament lamps.

24 Controls – End Product Test Parameters

24.1 General

24.1.1 Spacings of controls shall comply with the electrical spacing, or clearances and clearance distance requirements of the applicable control standard as determined in Section 6.5, Controls.

24.1.2 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.

24.2 Auxiliary controls

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

24.2.2 Auxiliary controls shall comply with the requirements of this end product standard.

Exception: An auxiliary control that complies with a component standard (s) specified in Section 6.5, Controls, is considered to fulfill this requirement.

24.3 Operating controls (regulating controls)

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

a) Control action Types 1 or 2;

b) Unless otherwise specified in this Standard, manual and automatic controls shall be tested for 6,000 cycles with under maximum normal load conditions, and 50 cycles under overload conditions. See 24.5.1.

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

d) For the applicable Overvoltage Category, see Table 24.1;

e) For the applicable Material Group, see Table 24.2;

f) For the applicable Pollution Degree, see Table 24.3.

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

a) Control action Types 1 or 2;

b) Unless otherwise specified in this Standard, manual and automatic controls shall be tested for 6,000 cycles with under maximum normal load conditions, and 50 cycles under overload conditions. See 24.5.1;

c) For the applicable Overvoltage Category, see Table 24.1;

d) For the applicable Material Group, see Table 24.2;

e) For the applicable Pollution Degree, see Table 24.3.

Table 24.1
Overvoltage categories

Appliance	Overvoltage category
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 24.2
Material group

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

Table 24.3
Pollution degrees

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

24.4 Protective controls (limiting controls)

24.4.1 An electronic control that performs a protective function shall comply with the requirements in 6.5 while tested using the parameters in this section. Examples of protective controls are: a control used to sense abnormal temperatures of components within the appliance; an interlock function to de-energize a motor; temperature protection of the motor due to locked rotor, running overload, loss of phase; or other function intended to reduce the risk of electric shock, fire, or injury to persons.

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

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

b) Power Supply Voltage Dips, Variation and Interruptions within a temperature range of 10°C and the maximum ambient temperature determined by conducting the Temperature Test, Section 40;

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 of 17.1.4.2 h) shall be conducted at ambient temperatures of 10.0 +2°C and the maximum ambient temperature determined by conducting the Temperature Test, Section 40. The test shall be conducted for 14 days; and

h) Overload shall be conducted based on the maximum declared ambient temperature (Tmax) or as determined by conducting the Temperature Test, Section 40.

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

24.4.3 The test parameters and conditions used in the investigation of the circuit covered by 24.4.1 shall be as specified in the 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 per meter 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 (0°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) When a Computational Investigation is conducted, Ip shall not be greater than X failures/106 hours for the entire system. The Operational Test is to be conducted for 14 days;

g) When the Demonstrated Method Test is conducted, the multiplier for the test acceleration factor is to be 576.30 for intermittent use appliances, or 5763.00 for continuous use appliances. The test acceleration factor equation is to be based on a 25°C 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; and

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

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

24.4.4 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.

24.5 Controls using a temperature sensing device

24.5.1 A temperature sensing positive temperature coefficient (PTC) or 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 an operating device – 6000 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.

25 Spacings

25.1 Other than at wiring terminals, the spacing between uninsulated current-carrying parts of opposite polarity, and between an uninsulated current-carrying part and a dead metal part that is exposed to contact by persons or that is capable of being grounded, shall not be less than the value specified in Table 25.1.

Exception No. 1: The inherent spacings of a component of the appliance, such as a snap switch, are investigated on the basis of the requirements for the component in question.

Exception No. 2: This requirement does not apply if a spacing complies with the requirements in 25.5.

Table 25.1
Minimum required spacings at other than field-wiring terminals

Potential involved, volts	Minimum spacings, mm (in)							
	An appliance employing a motor having a diameter of 177.80 mm (7 in) or less[a]				An appliance employing a motor having a diameter of more than 177.80 mm (7 in)[a]			
	Over surface		Through air		Over surface		Through air	
0 – 50	1.6	(1/16)	1.6	(1/16)	6.4[c]	(1/4)	3.2[c]	(1/8)
51 – 125	2.4[b]	(3/32)	2.4[b]	(3/32)	6.4[c]	(1/4)	3.2[c]	(1/8)
126 – 250	2.4	(3/32)	2.4	(3/32)	6.4[c]	(1/4)	6.4[c]	(1/4)

NOTE: For appliances without a motor, use the minimum spacings for an appliance employing a motor having a diameter of 177.8 mm (7 in) or less.

[a] See 20.1.4.

[b] For an appliance employing a motor rated at 1/3 horsepower (250 W output) or less, these spacings shall be not less than 1.6 mm (1/16 in).

[c] Film-coated wire is considered to be an uninsulated current-carrying part. However, a spacing of not less than 2.4 mm (3/32 in) over surface and through air between film-coated wire, rigidly supported and held in place on a coil, and a dead metal part is acceptable.

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

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

25.4 If an isolated dead metal part is interposed between or is in close proximity to current-carrying parts of opposite polarity, to a current-carrying part and an exposed dead metal part, or to a current-carrying part and a dead metal part that is grounded, a spacing of not less than 1.2 mm (3/64 in) between the isolated dead metal part and any one of the other parts mentioned above meets the intent of the requirement when

the total spacing between the isolated dead metal part and the two other parts (as described in the three examples above) is not less than the value specified in Table 25.1.

25.5 An insulating lining or barrier shall comply with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception No. 1: Vulcanized fiber not less than 0.4 mm (1/64 in) thick meets the intent of the requirement when used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

Exception No. 2: Thinner insulating material is usable when investigation reveals that it complies with the intent of the requirement for the application.

25.6 All uninsulated current-carrying parts connected to different (that is, line- or low-voltage) circuits shall be spaced from one another as though they were parts of opposite polarity, in accordance with the requirements in 25.1, and shall be investigated on the basis of the highest voltage involved.

25.7 The spacing between uninsulated current-carrying parts of opposite polarity, and between such parts and dead metal that is capable of being grounded in service, is not specified for parts of low-voltage circuits and between terminals of parts operating with opposite polarity of low voltage.

25.8 A printed wiring board with spacings between opposite polarity circuits (other than a low-voltage circuit, see 25.7) less than those required is determined to be acceptable when 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 41.5; or

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

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

d) Comply with the applicable requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840.

26 Seals and Gaskets

26.1 An appliance provided with a container into which liquid is intended to be added by the user shall preclude the following actions when such action is capable of resulting in the risk of fire or electric shock. Compliance is to be determined by the Flooding of Current-Carrying Parts Test, Section 42:

a) Overflow of liquids into the electrical or motor enclosure of the appliance,

b) Deterioration of seals, resulting in the entrance of liquid into the electrical or motor enclosure of the appliance.

26.2 If the failure of a liquid container provided as a part of an appliance is capable of resulting in the risk of fire or electric shock, the container shall be of a material which is compatible with the liquid intended to be used therein.

27 Consumables

27.1 Use of consumables that are furnished with or intended for use with the appliance shall not cause a risk of fire, electric shock, or injury to persons, as determined by the requirements of this Standard. See required testing in Consumables, Section 53.

27.2 Various consumables that are made available or recommended by the manufacturer for use with the basic appliance shall be included in the investigation of the appliance. Unless recommended by the manufacturer, not more than one consumable shall be investigated at a time with the appliance.

27.3 Containers housing consumables shall be liquid-tight and provided with a cover that cannot be removed without the use of a tool.

Exception: The consumable and its container also meet the intent of the requirement if it contains a carrier medium (e.g., wax) in which the total concentration of fragrance oil or gel is no greater than 30 percent by volume of the entire contents of the consumable in the container, and the consumable form (solid, liquid or gel) is not appreciably depleted during operation of the device over the entire stated life of the consumable fragrance. Appreciably depleted is defined as a reduction in total consumable volume of greater than 15 percent during operation of the unit over the entire life of the fragrance as stated by the manufacturer.

27.4 For containers housing liquid consumables for use in air freshening and deodorizing appliances employing a wick, liquid-tight shall be determined with the container positioned in the appliance as specified in the instruction manual. If the container has more than one normal use position, liquid-tight shall be determined with the container oriented in each use position specified.

27.5 With reference to 27.3, a wick is not considered a cover. However, a wick shall not loosen nor be permanently displaced when tested as described in Section 66, Liquid Tight Tests for Containers Employing Wicks.

28 Fragrances

28.1 The flash point of a liquid shall be conducted in accordance with 53.1. The resulting flash point shall be not less than 30°C (54°F) higher than the operating temperature (wick or pad temperature) of the device.

28.2 The flash point of the liquid need not comply with the 30°C temperature delta of 28.1, if all the following conditions are met:

a) The fragrance complies with the flame ignition test in 53.2 and;

b) The fragrance volume for normal use is less than 300 ml for the total volume; for appliances which utilize more than one fragrance container during normal use, the volume limitation is determined as a total of each container of fragrance used with the appliance, and;

c) The operating temperature of the heater as determined by the Temperature Test of Section 40 is less than 300°C, and;

d) The liquid container is not user refillable.

28.3 The flash point of the liquid need not comply with the 30°C temperature delta of 28.1, if all of the following conditions are met:

a) The fragrance complies with the flame ignition test in 53.2; and

b) The fragrance is subjected to the Ignition Temperature Test, in the Standard for Tests for Comparative Flammability of Liquids, UL 340 and the resulting Ignition Temperature is 50° C greater than the highest temperature of the following:

i) The operating temperature of the wick or pad as determined by the Temperature Test of Section 40; or

ii) The fragrance flash point as determined by the test of 53.1.

29 Transformers

29.1 A transformer shall comply with 6.21.

30 Secondary Circuits

30.1 General

30.1.1 A secondary circuit shall comply with the requirements for one of the following types of secondary circuits:

a) A Class 2 circuit;

b) A limited voltage/current circuit;

c) A limited energy circuit; or

d) A limiting impedance circuit.

30.2 Difference between the level of testing required within each type of secondary circuit

30.2.1 The following applies to secondary circuits that comply with the Class 2 requirements of 30.3.1 or the limited voltage/current requirements of 30.4.1 – 30.4.5 and the Secondary Circuit Voltage and Current Measurement Test, Section 65:

a) Components located within these circuits are not required to be investigated.

b) Spacings located within these circuits and from these circuits to earth ground or to the enclosure are not required to be tested. However, spacings from these circuits to other circuits shall be in accordance with Spacings, Section 25.

c) Accessing these circuits from outside the enclosure meets the intent of the requirement based on the inherent nature of a Class 2 or limited voltage/current circuit.

30.2.2 The following applies to secondary circuits that comply with the limited energy requirements of 30.5.1 – 30.5.3 circuit requirements and that involve open circuit potentials less than or equal to 30 V ac or 42.4 V peak:

a) Components located within these circuits are not required to be tested.

Exception: Printed-wiring boards shall be evaluated in accordance with Printed-Wiring Boards, Section 31. Wiring shall be evaluated in accordance with Internal Wiring – Electrical Connections, Section 14.

b) Spacings located within these circuits and from these circuits to earth ground or to the enclosure are not required to be investigated. However, spacings from these circuits to other circuits shall be in accordance with Spacings, Section 25.

c) These circuits shall not be accessible from outside the enclosure. Therefore, when these circuits provide power to components that extend through the enclosure, the ability of these components to serve as an enclosure shall be investigated.

30.2.3 The following applies to secondary circuits that comply with the limited energy requirements of 30.5.1 – 30.5.3 and that involve open circuit potentials in excess of 30 V ac or 42.4 V peak:

a) Components located within these circuits are not required to be investigated.

Exception: Printed-wiring boards shall be evaluated in accordance with Printed-Wiring Boards, Section 30. Wiring shall be evaluated in accordance with Internal Wiring – Electrical Connections, Section 14. The effects of heat-generating power components on adjacent components, such as printed wiring boards and wiring, shall be evaluated in accordance with the temperature requirements in the Temperature Test, Section 40.

b) Spacings located within these circuits are not required to be investigated. However, spacings from these circuits to earth ground or to the enclosure, and spacings from these circuits to other circuits, shall be in accordance with Spacings, Section 25.

c) These circuits shall not be accessible from outside the enclosure. Therefore, when these circuits provide power to components that extend through the enclosure, the ability of these components to serve as an enclosure shall be investigated.

30.2.4 The following applies to secondary circuits that comply with the limiting impedance requirements of 30.6.1 – 30.6.2:

a) Components located within these circuits are not required to be investigated.

b) Spacings located within these circuits and from these circuits to earth ground or to the enclosure are not required to be investigated. However, spacings from these circuits to other circuits shall be in accordance with Spacings, Section 25.

c) Accessing these circuits from outside the enclosure meets the intent of the requirement based on the inherent nature of a limited impedance circuit.

Exception: Circuits supplied from a limiting impedance that complies with Exception No. 1 to 30.6.2 shall not be accessible from outside the enclosure. Therefore, when these circuits provide power to components that extend through the enclosure, the ability of these components to serve as an enclosure shall be investigated.

30.3 Class 2 circuit requirements

30.3.1 A Class 2 circuit shall be supplied by an isolating source that complies with the requirements in the Standard for Class 2 Power Units, UL 1310, or the requirements in the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

30.4 Limited voltage/current circuit requirements

30.4.1 A limited voltage/current circuit shall be supplied by an isolating source or by the secondary winding of an isolating type transformer, such that the maximum open circuit voltage potential available to the circuit is not more than 30 V ac or 42.4 V peak and the current available is limited to a value not exceeding 8 amperes measured after 1 minute of operation. The transformer shall comply with the requirements Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1; Standard for Class 2 Power Units UL 1310; or Standard for Information Technology Equipment– Safety–

Part 1: General Requirements UL 60950-1. See the Secondary Circuit Voltage and Current Measurement Test, Section 65, for a description of the test method.

30.4.2 When a fuse or other such circuit protective device is located in the secondary circuit and is used to limit the available current in accordance with 30.4.1, it shall be rated at not more than the values specified in Table 30.1; see 30.4.3. When a fuse or other such circuit protective device is located in the primary circuit, its current rating is not restricted of the protective device as long as it limits the available secondary current in accordance with Table 30.1.

Table 30.1
Rating for fuse or circuit protective device

Open circuit volts (peak)	Amperes
0 – 20	5.0
Over 20 – 30	100/V[a]
[a] V is defined as the peak open circuit voltage.	

30.4.3 The overcurrent protective device mentioned in 30.4.2 shall:

a) Not be of the automatic reset type;

b) Be trip-free from the reclosing mechanism when of the manual reset type; and

c) Not be interchangeable with one of a larger current rating when it is a renewable device.

30.4.4 When a protective device is used as specified in 30.4.2, this protective device shall comply with the requirements in Spacings, Section 25, and shall be provided with an adjacent replacement marking and replacement instructions that include the required voltage and current rating. The printed wiring board, wiring, and spacings, prior to the point at which the voltage and current are suitably limited, shall comply with the requirements of this Standard.

30.4.5 A fixed impedance (such as a component or grouping of components in the same circuit) or a regulating network (such as is used in a switching type power supply) meets the intent of limiting the voltage and/or the available current in accordance with 30.4.1. Such a fixed impedance or regulating network shall be able to function under single component fault conditions.

30.5 Limited energy circuit requirements

30.5.1 A limited energy circuit shall be supplied by an isolating source such that the maximum volt-ampere capacity available to the circuit is 200 volt-amperes or less at a maximum open circuit voltage potential of 100 V AC. The secondary winding of an isolating type transformer meets the intent of compliance with this requirement. The transformer shall comply with the requirements Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1; Standard for Class 2 Power Units, UL 1310; or Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1.

30.5.2 A primary or secondary circuit fuse or other such circuit protective device meets the intent of limiting the maximum available volt-ampere capacity in accordance with 30.5.1. While there are no restrictions on the current rating of this protective device as long as it limits the available secondary volt-ampere limit in accordance with 65.2, the protective device shall comply with the requirements of this Standard and shall be provided with a replacement marking or replacement instructions that includes the required voltage and current rating. The printed wiring board, wiring, and spacings prior to the point at which the voltage and volt-ampere capacity are suitably limited shall comply with the requirements of this Standard.

30.5.3 The overcurrent protective device mentioned in 30.5.2 shall:

a) Not be of the automatic reset type;

b) Be trip-free from the reclosing mechanism when of the manual reset type; and

c) Not be interchangeable with one of a larger current rating when it is a renewable device.

30.6 Limiting impedance circuit requirements

30.6.1 A limiting impedance circuit shall be supplied by an impedance that complies with the following:

a) The calculated power dissipation of the impedance, as the result of a direct short applied across the circuit downstream of the impedance, does not exceed the power rating of the impedance;

b) The power dissipation of the impedance is not greater than 15 watts; and

c) There does not exist a risk of shock, as defined in 4.33 downstream of the impedance.

Exception: A limiting impedance circuit still meets the intent of the requirement when using an impedance that complies with the following:

a) The impedance shall be rated such that the calculated power dissipation of the impedance, as the result of a direct short applied across the circuit downstream of the impedance, exceeds the power rating of the impedance and is still less than 15 watts;

b) The impedance shall not open or short when subjected to the effects of a direct short applied across the circuit downstream of the impedance. The method for setting up this limiting impedance test is the same as the method for setting up the Abnormal Operation Test, Section 48; and

c) There does not exist a risk of shock, as defined in 4.33, downstream of the impedance.

30.6.2 The limiting impedance referred to in 30.6.1 shall be able to function under single component fault conditions.

Exception No. 1: When the circuit limited by this impedance is enclosed, this limiting impedance is not required to function under single component fault conditions.

Exception No. 2: A single resistor serving as a limiting impedance is determined to comply with this requirement without further investigation.

Exception No. 3: A single capacitor serving as a limiting impedance is determined to comply with this requirement without further investigation when the capacitor complies with requirements in the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14.

31 Printed-Wiring Boards

31.1 A printed-wiring board shall comply with the requirements in the Standard for Printed-Wiring Boards, UL 796, including direct support criteria, and shall be classified V-0, V-1, or V-2, in accordance with the requirements in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

31.2 A resistor, capacitor, inductor, or other part that is mounted on a printed-wiring board to form a printed-wiring assembly shall be secured so that it is not displaced to result in a risk of electric shock or fire by a force typically exerted during assembly, normal operation, or servicing of the appliance.

31.3 Consideration is to be given to a barrier or a partition that is part of the device, and that provides mechanical protection and electrical insulation of a component connected to the printed-wiring board.

32 Electronic Circuits

32.1 Malfunction of a component such as a diode, transistor, thyristor, electrolytic capacitor, integrated circuit, optical isolator, or other solid-state device (that is, any device whose operation is dependent upon any combination of optical, electrical, or magnetic phenomena within a solid) shall not result in a risk of fire, electric shock or injury to persons when subjected to the Abnormal Operation Test, Section 48.

Exception No. 1: A component located in the following circuits is not required to be subjected to the Abnormal Operation Test:

a) Circuits that comply with the requirements for Secondary Circuits, Section 30.

b) Circuits that has been investigated to the requirements in the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, for reliability; and

c) Circuits used in low voltage component appliances.

Exception No. 2: This requirement does not apply to resistors, non-electrolytic capacitors, inductors, transformers, electromechanical devices such as switches and relays, and optical isolators that comply with the applicable requirements as specified elsewhere in this Standard.

32.2 Compliance with 32.1 requires an analysis of the circuit to determine whether malfunction of a component results in a risk of fire, electric shock or injury to persons. This analysis requires the opening and short circuiting of a component (electrolytic capacitor, transistor junction, or similar device) and observation of the ultimate results of the simulated malfunction or breakdown. Only one condition of simulated malfunction or breakdown is to be imposed at one time.

33 Insulation Systems

33.1 Class A insulation systems shall consist of a combination of magnet wire and major component insulation materials evaluated and found to operate as intended in its end use. Thermoset materials and materials in Table 33.1 at the thicknesses specified are permitted to be used without further evaluation.

33.2 For Class A insulation systems employing other materials or thinner materials than those indicated in Table 33.1 or a combination of materials, the materials, whether polymeric or not polymeric (treated cloth, for example), shall comply with the requirements in 33.3.

33.3 A polymeric material employed in a Class 105 (A) insulation system that isolates the windings from dead metal parts shall be unfilled or glass-reinforced nylon, polycarbonate, polybutylene terephthalate, polyethylene terephthalate, phenolic or acetal, and shall have a relative or generic thermal index for electrical properties of 105° C minimum. Leads shall be rated 90° C minimum. Motors employing thermoplastic materials shall be subjected to the tests in thermoplastic motor insulation systems, Section 68.

Exception: Other polymeric materials used in a Class 105 (A) insulation system shall comply with the requirements for thermal aging in 68.4.

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

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

Table 33.1
Primary Class A insulating materials and minimum thicknesses

Material	Minimum thickness	
	mm	(in)
Vulcanized fiber	0.71	(0.028)
Polyethylene terephthalate film	0.18	(0.007)
Cambric	0.71	(0.028)
Treated cloth	0.71	(0.028)
Electrical grade paper	0.71	(0.028)
Mica	0.15	(0.006)
Aramid paper	0.25	(0.010)

34 Protection Against Injury to Person

34.1 General

34.1.1 If the operation and maintenance of an appliance by the user involves the risk of injury to persons, protection shall be provided to reduce the risk. Consideration shall also be given to reasonably foreseeable misuse of the appliance.

34.1.2 A functional consumable that is made available or recommended by the manufacturer for use with the basic appliance shall be included in the investigation of the appliance. Unless the manufacturer recommends the use of two or more consumables at the same time, only one consumable at a time is to be investigated with the appliance.

34.1.3 Whether a guard, release, interlock, or similar securing mechanism is required and whether such a device is able to perform its intended function shall be determined from an investigation of the complete appliance, its operating characteristics, and the risk of injury to persons resulting from a cause other than gross negligence. The investigation shall include an examination of the results of breakdown or malfunction of any one component, but not more than one component at a time, unless one event contributes to another. If the investigation shows that breakdown or malfunction of a particular component can result in a risk of injury to persons, that component shall be investigated for reliability.

34.1.4 Specific constructions, tests, markings, guards, and similar structures are detailed for some common constructions. Specific features and appliances not covered herein are to be examined further as they are identified.

34.2 Sharp edges

34.2.1 An enclosure, frame, guard, impeller, detachable part, handle, or similar part whose surfaces are exposed to contact during normal maintenance and use shall not present a risk of injury to persons. There shall be no sharp edges as determined by the Standard for Tests for Sharpness of Edges on Equipment, UL 1439.

34.2.2 Direct plug-in Deodorizers and Air Fresheners with child appealing features with removable parts shall not present a risk of injury to persons from a sharp edge after being subjected to the Impact Test, Section 61. Detachable parts are to be tested both attached to the appliance and separated from the appliance including consumable containers. Refer to 61.1.2.

34.3 Enclosures and guards

34.3.1 With reference to 34.3.2, the design and intended use of an appliance provided with a fan is to be considered when investigating an enclosure or guard.

34.3.2 The rotor of a motor appliance or other moving part that poses a risk of injury to persons shall be enclosed or provided with other means to reduce the risk of unintentional contact, and such a part shall not be contacted by the probe illustrated in Figure 10.1.

Exception No. 1: An opening in the integral enclosure of a motor that is unable to be contacted by the probe illustrated in Figure 10.2 is determined to comply with the intent of this requirement.

Exception No. 2: A part or portion of a part that must be exposed to perform the work function is not required to be enclosed but guarding shall be provided as required for additional protection. See 34.3.5.

Exception No. 3: A part that complies with 34.3.8 is not required to be guarded.

34.3.3 During the examination of an appliance to determine whether it complies with the requirements in 34.3.2, a part of the enclosure that is capable of being removed without the use of a tool (to attach an accessory, to make an operating adjustment, or for other reasons) is to be opened or removed.

34.3.4 Among the factors to be used in judging whether an exposed moving part introduces a risk of injury to persons are:

a) The degree of exposure required to perform the intended function;

b) The sharpness of the moving part;

c) The risk of unintentional contact with the moving part;

d) The speed of the moving part;

e) The risk that a part of the body is able to be endangered or that clothing is able to be entangled by the moving part, resulting in a risk of injury to persons;

f) The portion of a blade of a fan being contacted – trailing edge, leading edge, or periphery; and

g) The blade material and angle, and type and sharpness of the exposed edge of a fan.

These factors are to be reviewed with respect to both intended operation of the appliance and any reasonably foreseeable misuse.

34.3.5 Some guards are required to be self-restoring. Other features of guards that are to be considered include:

a) Removability without the use of a tool;

b) Removability for servicing or replenishing consumables;

c) Strength and rigidity;

d) Completeness;

e) Creation of a risk of injury to persons, such as a pinch point, and the necessity for additional handling because of the increased need for servicing, such as for cleaning, unjamming, and similar operations; and

f) Usage – household or commercial.

34.3.6 An enclosure or guard over a rotating part shall retain a part that, because of breakage or other reasons, is capable of becoming loose or separating from a rotating part, and shall retain a foreign object that is capable of being struck and propelled by the rotating part.

34.3.7 A moving part such as an impeller is not required to be guarded when the moving part complies with all of the following applicable requirements:

a) When motor-driven, the impeller:

1) Does not weigh more than 45 g (0.1 lb);

2) Is not more than 203.2 mm (8 in) in diameter; and

3) Is not more than 3.2 mm (1/8 in) thick and has no reinforcement beyond the nose cone.

b) The moving part:

1) Does not rotate faster than 2000 revolutions per minute; and

2) Complies with the requirements specified in the Unguarded Impeller Test, Section 55 and the Impact Test, Section 61.

c) The power of the motor driving the part is not more than 35 watts (0.047 horsepower).

d) The "K" factor of the moving part determined as specified in 34.3.9 is less than 732.

e) A blade:

1) Employs a rounded leading edge with a diameter of at least 3.2 mm (1/8 in); and

2) Is composed of material having:

i) A tensile strength of at least 6.895 MPa (1000 psi); and

ii) A tangent modulus of elasticity not more than 206.85 MPa (30,000 psi).

Exception No. 1: An unguarded impeller is not required to comply with the requirements of 34.3.7 (a)(1), (a)(2), (c), and (d) when the appliance complies with 34.3.8.

Exception No. 2: This requirement does not apply to an unguarded impeller when the appliance complies with 34.3.9.

34.3.8 An unguarded impeller that complies with the Exceptions to 34.3.7 shall produce an impact force of 175 N (39.34 lb) or less.

34.3.9 Conventional designs of impellers meet the requirement of being guarded when:

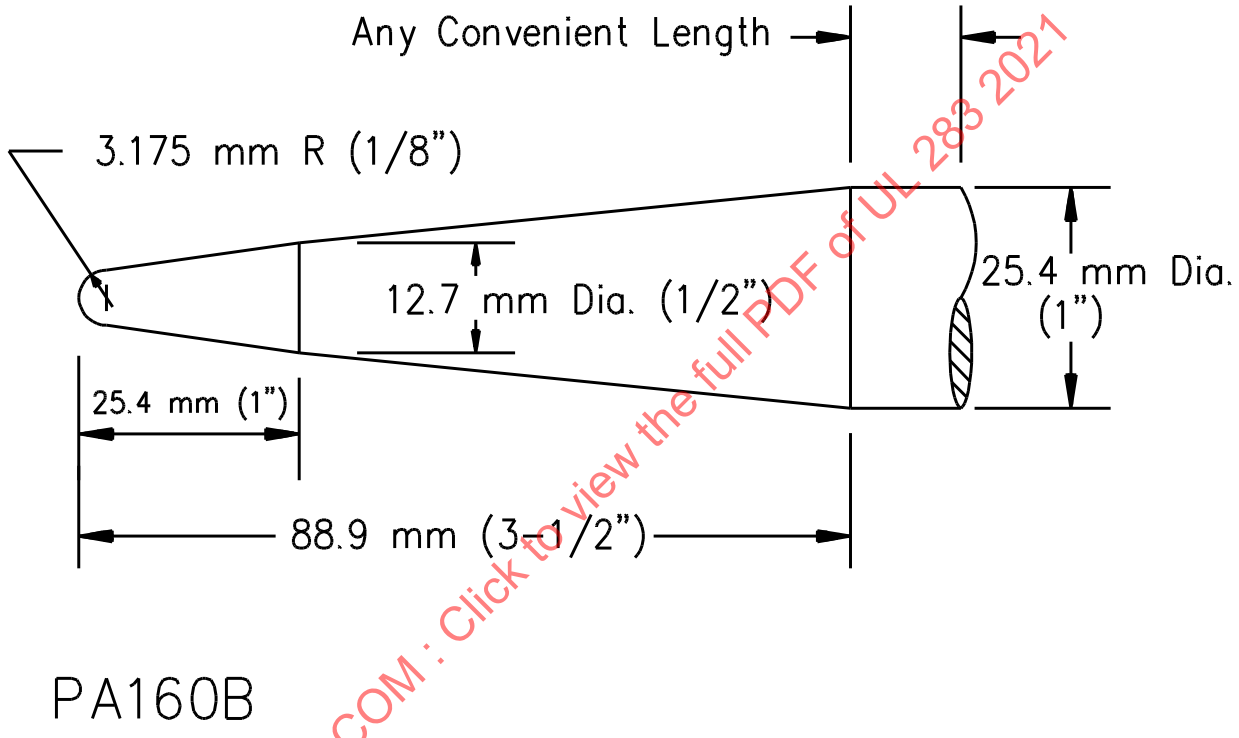
a) The relationship between mass (W) in kg, radius (r) in mm, and speed (N) in revolutions per minute is such that K in the following equation is less than 29264:

$$K = 6 \times 10^{-7} (Wr^2 N^2)$$

b) The guarding is such that the probe illustrated in Figure 34.1 cannot touch the leading edge of the blade and hub when inserted as described in 34.3.10. For an appliance with a reversible fan, both edges of the blade are considered leading edges. When K is greater than 29264, the probe shall not touch any part of the impeller.

Figure 34.1

Probe for impellers of portable appliances



34.3.10 The portion of an impeller that entails a risk of injury to persons shall be guarded so that the probe illustrated in Figure 34.1 does not touch the part when inserted with a force of 4.45 N (1 lb) for a maximum of 5 seconds through any opening in the guard.

34.3.11 During an examination to determine whether an appliance complies with the requirements specified in 34.3.10, the guards and impellers are not to be removed before examination.

34.3.12 When a part used to comply with the requirement in 34.3.10 is made of a polymeric material, a representative part is to be exposed for 7 hours to air at 70°C (158°F). While in the oven, the part is to be assembled to the appliance and the appliance is to be in its intended operating position. After the part has cooled to room temperature, the probe illustrated in Figure 34.1 is to be inserted through each opening in the guard. The probe shall not be able to touch any portion of an impeller that can cause a risk of injury to persons.

34.3.13 A guard employed to comply with the requirement in 34.3.10 shall be attached to the appliance in any of the following ways:

a) Permanently;

b) By means requiring the use of a tool or tools for removal; or

c) By means not requiring the use of a tool or tools for removal such that the securing means remain attached to the front or rear guard; and

1) Two separate motions (for example, push and turn) are required to disengage the securing means; or

2) A force of 22.24 N (5 lb) is required to disengage the securing means.

34.3.14 The removal force specified in 34.3.13(c)(2) is to be measured after conditioning the holding means by removing and replacing the guard ten times in the intended manner.

34.3.15 Polymeric guards, which are used for protecting the impeller and also function as an electrical enclosure, shall be subjected to the requirements of the Impact Test, Section 61.

34.4 Rotating or moving members

34.4.1 A rotating or moving part, that if it becomes disengaged is capable of introducing a risk of injury to persons, shall be provided with a means to retain the part in place under conditions of use.

34.4.2 A rotating member, the breakage of which is capable of introducing a risk of injury to persons, shall be constructed to reduce the risk of its breakage, or the release or loosening of a part that is capable of introducing a risk of injury to persons. Refer to the Overspeed Test, Section 64.

34.5 Switches, controls, and interlocks

34.5.1 An appliance shall be constructed so as to reduce the risk of unexpected operation of any part capable of causing injury to persons. Consideration should be given to each function of a multiple-function appliance.

34.5.2 If unintentional operation of a switch or an interlock switch can result in a risk of injury to persons, the actuator of the switch shall be located or guarded so that such operation does not occur. Several methods, such as recessing, ribs, barriers, or similar means of protection, are used to guard the actuator of a switch.

34.5.3 Operation of an interlock in normal use shall not inconvenience the operator so as to encourage deliberate defeat of the interlock.

34.5.4 An interlock shall not be capable of being defeated by materials that accumulate in normal use.

34.5.5 An interlock shall be such that it cannot be defeated readily:

a) Without damaging the appliance;

b) Without making wiring connections or alterations; or

c) By using materials that are readily available.

34.5.6 If an interlock is actuated by movement of a guard, the arrangement shall be such that the guard is in place when the interlock is in the position that enables operation of the parts being guarded. With the guard removed, the interlock shall comply with the requirements in 34.5.2.

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

34.5.8 The requirement in 34.5.7 shall dictate the use of an interlock if moving parts or other items associated with the appliance introduce a risk of injury to persons upon the automatic starting or restarting of the motor.

34.6 Hot liquids

34.6.1 The maximum temperature of a liquid in a heating-type appliance is to be measured using thermocouples in accordance with the Temperature Test, Section 40, and shall not exceed 65°C (149°F) during normal use. If the liquid temperature exceeds 65°C (149°F), then a locking-type lid is required to keep the heated liquid from spilling if the appliance is tipped over. See the Tip-Over Test, Section 52.

Exception: If the liquid capacity of the reservoir is less than 5 ounces and the liquid consumable contains a carrier medium (for example, wax) in which the total concentration of fragrance oil or gel is no greater than 30 percent by volume of the entire content of the consumable, a temperature of not more than 75°C (167°F) is permitted without a locking lid.

34.6.2 When a locking-type lid is required, it shall be non-detachable, and require two separate and distinct motions to open.

PERFORMANCE

35 General

35.1 Unless otherwise rated, appliances shall be tested at a frequency of 60 Hz and a potential in accordance with Table 35.1 for each test described.

Table 35.1
Test voltages

Rated voltage	Input test voltage	Other test voltage unless otherwise specified
110 – 120	Rated	120
191 – 208	Rated	208
210 – 240	Rated	240
NOTE: For a nameplate rating other than one of those specified in the table, the appliance is to be tested at 100 – 105 percent of the rated voltage. However, the voltage of the intended source of supply for an appliance is also regarded as a usable rating for test.		

36 Leakage-Current Test

36.1 An appliance rated for a nominal 120-volt supply shall be tested in accordance with 36.3 – 36.7. Leakage-current shall not be more than:

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

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

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

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

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

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

36.3 All exposed conductive surfaces are to be tested for leakage currents. If simultaneously accessible, the leakage currents from exposed conductive surfaces are to be measured to the grounded supply conductor individually as well as collectively, and from one surface to another. A part is considered to be an exposed surface unless guarded by an enclosure that complies with the requirements in Accessibility of Uninsulated Current-Carrying Parts, Film-Coated Wire and Moving Parts, Section 10. Surfaces are identified as simultaneously accessible when they are capable of being readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages that do not present a risk of electric shock. If all accessible conductive parts are bonded together and connected to the grounding conductor of the power-supply cord, the leakage current can be measured between the grounding conductor of the appliance and the grounded supply conductor.

36.4 If a material other than metal is used for the enclosure or part of the enclosure, the leakage-current is to be measured using a metal foil having an area of 10 by 20 cm in contact with the surface. If 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.

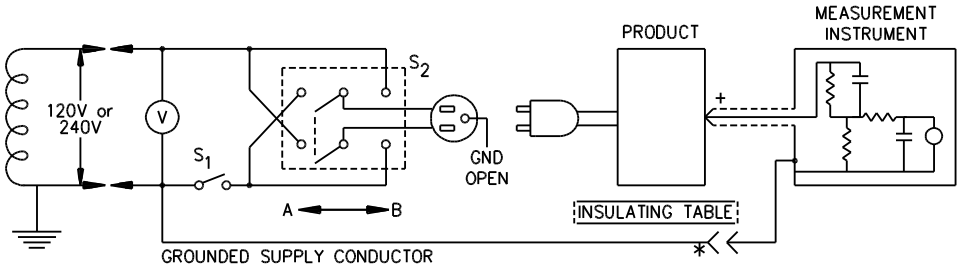
36.5 Typical measurement circuits for leakage current with the ground connection open are illustrated in Figure 36.1. The measurement instrument is defined in Figure 36.2. The meter that is actually used for a measurement is required only to indicate the same numerical value for a particular measurement as the defined instrument and is not required to have all the attributes of the defined instrument. Over the frequency range 20 Hz to 1 MHz with sinusoidal currents, the performance of the instrument is to be as follows:

a) The measured ratio V_1/I_1 with sinusoidal voltages is to be as close as feasible to the ratio V_1/I_1 calculated with the resistance and capacitance values of the measurement instrument shown in Figure 36.2.

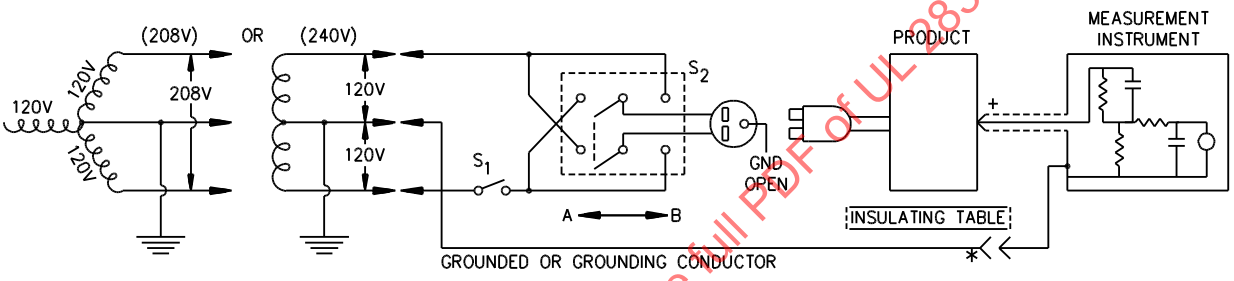
b) The measured ratio V_3/I_1 with sinusoidal voltages is to be as close as feasible to the ratio V_3/I_1 calculated with the resistance and capacitance values of the measurement instrument shown in Figure 36.2. V_3 is to be measured by the meter M in the measuring instrument. RMS volts can be converted to milliamps by dividing the reading by 500 Ohms and then multiplying the quotient by 1,000. The mathematic equivalent is to simply multiply the RMS voltage reading by 2.

Figure 36.1

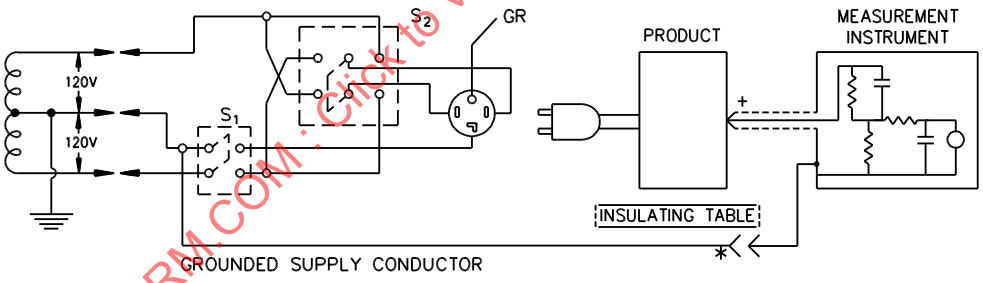
Leakage-current measurement circuit



Appliance intended for connection to a 120–volt or an end–grounded 2–wire, 240–volt power supply, as illustrated above.



2–wire appliance intended for connection to a 3–wire 208–volt or a 3–wire 240–volt 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 –

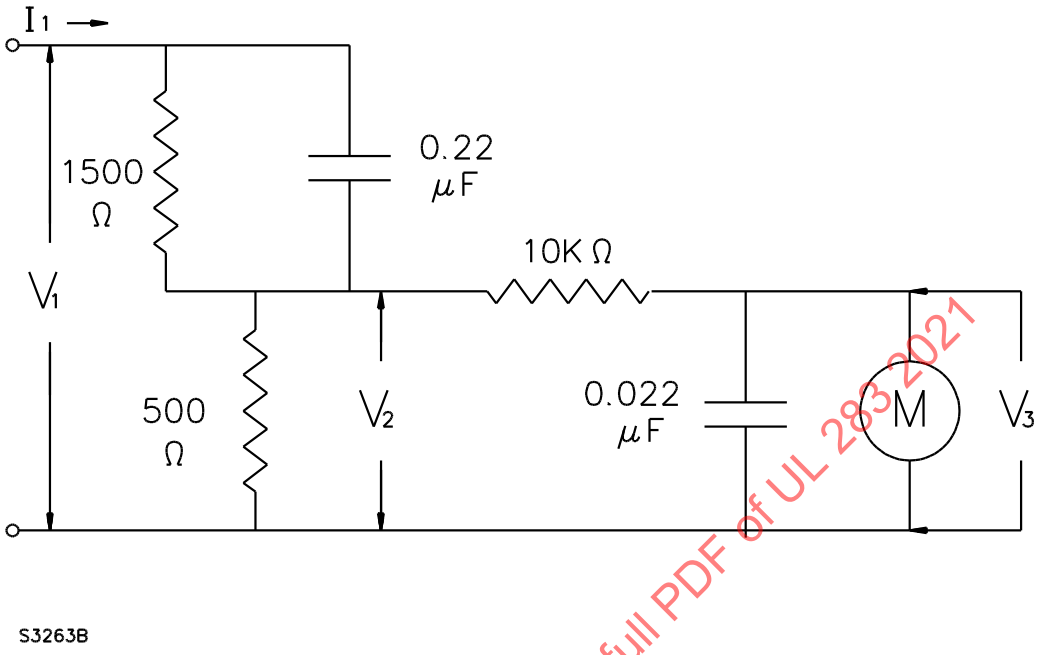
\+ – Probe with shielded lead.

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

LC300T

Figure 36.2

Measurement instrument for leakage current



Note – Detailed specifications and guidance for the calibration of this instrument are given in the American National Standard for Leakage Current for Appliances, UL 101.

36.6 The meter is to be connected to the accessible part and the grounded supply conductor unless the meter is being used to measure leakage between two parts of an appliance.

36.7 A representative appliance is to be tested for leakage-current starting with the as-received condition but with its grounding conductor, if any, open at the attachment plug. The as-received condition of the appliance is a function of production-line testing, during which prior energization of the appliance is determined to be a normal occurrence. The supply voltage is to be adjusted to 120 volts. The test sequence, with reference to the measuring circuit (Figure 36.1) 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, and with the appliance switching devices in all their normal operating positions.

b) Switch S1 is then to be closed energizing the appliance. Within 5 seconds, the leakage-current is to be measured using both positions of switch S2 and with the appliance switching devices in all their normal operating positions.

c) The leakage-current is to be monitored until thermal stabilization. Both positions of switch S2 are to be used in determining this measurement. Thermal stabilization is to be obtained by operation as in the Temperature Test.

d) The leakage current is also to be monitored with switch S1 open while the appliance is at operating temperature and while cooling.

36.8 Normally, the complete leakage-current test program as covered by 36.7 is to be conducted without interruption for other tests. However, with the concurrence of those concerned, performance of other nondestructive tests shall be a valid reason to interrupt the leakage-current tests.

37 Test of Insulation Resistance and Leakage-Current as a Result of Moisture

37.1 Except as noted in 37.2, an appliance that is capable of being 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 37.2 – 37.5. The test shall not result in the entrance of water into the interior of the appliance such that the water comes into contact with uninsulated current-carrying parts.

37.2 An appliance marked to indicate that it is not intended for immersion is not required to comply with the requirements in 37.1. See 72.1.7.

37.3 Each of three representative appliances is to be heated and 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 72.1.7), in which case each appliance is to be immersed only to the extent indicated. After 1 hour of immersion, the appliances 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 appliances are to be tested for leakage-current as indicated in the Leakage-Current Test, Section 36.

37.4 The entire procedure of immersion and leakage-current measurement is to be repeated four times, after which each appliance is to be subjected to a 1000 V dielectric voltage-withstand test, as described in 41.1. The three appliances are to be used for aging tests, and are required to comply with the requirements in the Test for Reliability of Parts Not Subject to Flexing, Section 44. If there is an air cavity having electrical components, the three appliances are to be disassembled and the internal parts visually examined for the presence of water per 37.1. See Table 37.1.

Table 37.1
Immersion tests for appliances intended to be immersed[a]

First 5 cycles	Dry initially and throughout conditioning Immerse for 1 hour Dry with cloth Conduct leakage-current test
After 5th cycle	Conduct dielectric voltage-withstand test Operate 240 hours Cool to room temperature Reheat as for normal-temperature test Immerse for 1 hour Conduct leakage-current test Conduct dielectric voltage-withstand test

[a] If there is an air cavity housing electrical components in the appliance, disassemble the appliance and examine for water.

37.5 An immersible heating 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.

38 Humidity Conditioning Test

38.1 After conditioning as specified in 38.2:

a) The appliance shall comply with the dielectric voltage-withstand requirements in 41.1;

b) For a cord-connected appliance rated 240 volts or less, the leakage current shall be not more than the applicable value in 36.1; and

c) For an appliance other than as mentioned in (b), the insulation resistance between current-carrying parts and exposed dead metal parts shall be not less than 50,000 ohms.

38.2 For the conditioning mentioned in 38.1, a representative appliance is to be heated to a temperature just above 34°C (93°F) to reduce the risk of condensation of moisture during conditioning. The heated appliance is then to be placed in the humidity chamber and conditioned for 48 hours in air having a relative humidity of 88 ±2 percent and a temperature of 32 ±2°C (90 ±4°F). Following the conditioning:

a) A cord-connected appliance rated for a nominal 240-volt supply or less is to be tested in the unenergized condition as specified in 36.7(a). The appliance is then to be energized and tested as specified in 36.7 (b) – (d). The test is to be discontinued when the leakage current stabilizes or decreases.

b) An appliance other than as mentioned in (a) is to have an insulation resistance of 50,000 ohms or more between current-carrying parts and interconnected dead metal parts.

c) An appliance shall comply with the dielectric voltage-withstand requirements in 41.1.

38.3 Insulation resistance is to be measured by means of a high-resistance voltmeter using a 250-volt, direct-current circuit.

39 Input Test

39.1 The current or wattage input to an appliance shall not be more than 105 percent of the rated value for a heating appliance, 110 percent for motor and/or combination motor/heater appliances, or the wattage input for an appliance rated 50 watts or less shall not be more than 10 watts above the rated value when the appliance is operated under the condition of maximum normal load as applicable, and when connected to a supply circuit of maximum rated voltage and rated frequency.

40 Temperature Test

40.1 All appliances

40.1.1 When tested as described in 40.1.3 – 40.1.13, an appliance shall not:

a) Attain constant temperatures at any point on the appliance high enough to result in a risk of fire;

b) Cause deterioration of any materials employed in the appliance; or

c) Have constant temperature rises at specific points (particularly those surfaces that are able to be contacted by the user with the appliance operating as intended) more than those specified in Table 40.1; see 40.1.10.

Table 40.1
Maximum acceptable temperature rises

Materials and components	°C[h]	(°F)[i]
ALL APPLIANCES		
1. Varnished-cloth insulation	60	(108)
2. Fuses	65	(117)
3. Fiber employed as electrical insulation	65	(117)
4. Wood and other combustible material	65	(117)
5. A surface upon which a stationary appliance is mounted in service, and surfaces that are adjacent to the appliance when so mounted	65	(117)
6. Class A insulation systems on coil windings of a universal motor, and on a reactor		
a) In an open motor:		
Thermocouple method	65[a]	(117)[a]
Resistance method	75	(135)
b) In a totally enclosed motor:		
Thermocouple method	70	(126)
Resistance method	80	(144)
7. Class A insulation systems on coil windings of an a-c motor having a diameter of 177.8 mm (7 in), or less (not including a universal motor)		
a) In an open motor:		
Thermocouple or resistance method	75[a]	(135)[a]
b) In a totally enclosed motor:		
Thermocouple or resistance method	80	(144)
8. Class B insulation systems on coil windings of a d-c motor and of a universal motor		
a) In an open motor:		
Thermocouple method	85[a]	(153)[a]
Resistance method	95	(171)
b) In a totally enclosed motor:		
Thermocouple method	90	(162)
Resistance method	100	(180)
9. Class B insulation systems on coil windings of an a-c motor having a diameter of 177.8 mm (7 in) or less (not including a universal motor) and on a vibrator coil		
a) In an open motor and on a vibrator coil:		
Thermocouple or resistance method	95[a]	(171)[a]
b) In a totally enclosed motor:		
Thermocouple or resistance method	100	(180)
10. Class E insulation systems on coil windings of an a-c motor having a diameter of 177.8 mm (7 in) or less (not including a universal motor) and on a vibrator coil		
a) In an open motor and on a vibrator coil:		
Thermocouple or resistance method	85[a]	(153)[a]
b) In a totally enclosed motor:		
Thermocouple or resistance method	90	(162)
11. Class E insulation systems on coil windings of an a-c motor having a diameter of more than 177.8 mm (7 in) (not including a universal motor) and on a vibrator coil		

Table 40.1 Continued on Next Page

Table 40.1 Continued

Materials and components	°C[h]	(°F)[i]
a) In an open motor and on a vibrator coil:		
Thermocouple method	75[a]	(135)[a]
Resistance method	85	(153)
b) In a totally enclosed motor:		
Thermocouple method	80	(144)
Resistance method	90	(162)
12. Class F system on coil windings of an a-c motor having a frame diameter of 177.8 mm (7 in) or less, not including a universal motor		
a) In an open motor:		
Thermocouple or resistance method	120	(216)
b) In a totally enclosed motor:		
Thermocouple or resistance method	125	(225)
13. Class H system on coil windings of an a-c motor having a frame diameter of 177.8 mm (7 in) or less, not including a universal motor		
a) In an open motor:		
Thermocouple or resistance method	135	(243)
b) In a totally enclosed motor:		
Thermocouple or resistance method	140	(252)
14. Phenolic composition employed as electrical insulation or as part of the deterioration of which results in a risk of fire, electric shock or injury to persons	125[b]	(225)[b]
15. Rubber or thermoplastic-insulated wires and cords	35[b,c,d]	(63)[b,c,d]
16. Capacitors		
Electrolytic	40[e]	(72)[e]
Other types	65[f]	(117)[f]
17. Sealing compound	40°C (72°F) less than melting point	
18. Class 105 insulation systems on windings of a relay, a solenoid, and similar devices.		
Thermocouple method	65[a]	(117)[a]
Resistance method	85	(153)
19. Class 130 insulation systems on windings of a relay, a solenoid, and similar devices.		
Thermocouple method	85[a]	(153)[a]
Resistance method	105	(189)
20. Class 155 insulation systems on windings of a relay, a solenoid, and similar devices		
Thermocouple method	110[a]	(230)[a]
Resistance method	115	(239)
21. Lampholder screw shell, center contact, or other connecting device of aluminum or unplated copper	175	(315)
22. Lampholder body of thermosetting material (phenolic, urea, and similar composition)	125	(225)

[a] On the surface of an insulated coil where the temperature is affected by an external source of heat (integral lights are not determined to be external sources of heat), the temperature rise measured by a thermocouple is able to be higher than the specified maximum, if the temperature rise of the coil measured by the resistance method is not more than that specified in the table. The additional temperature rises which meet the intent of the requirement above the values specified are:

Item	Temperature

Table 40.1 Continued on Next Page

Table 40.1 Continued

Materials and components		°C[h]	(°F)[i]
Part A of item 7	15°C (27°F)		
Part A of item 8	5°C (9°F)		
Item 15	15°C (27°F)		
Part A of item 16	20°C (36°F)		
Part A of item 17	10°C (18°F)		
Item 18	20°C (36°F)		

[b] The temperature limitations on phenolic composition, and on rubber and thermoplastic insulation do not apply to a compound that has been investigated and found to have the intended heat-resistance properties.

[c] Rubber-insulated conductors within a Class A insulated motor and rubber-insulated motor leads, and a rubber-insulated flexible cord entering a motor that are subjected to a temperature rise of more than 35°C (63°F) meet the intent of the requirement, when the conductors of other than a flexible cord employ a braid that is determined to be usable upon visual inspection. This does not apply to thermoplastic-insulated wires or cords.

[d] A short length of rubber or thermoplastic-insulated flexible cord exposed to a temperature rise of more than 35°C (63°F), such as at terminals, meets the intent of the requirement when supplementary heat-resistance insulation of intended dielectric strength is employed on the individual conductors of the cord to reduce the risk of deterioration of the conductor insulation, and when the strain-relief means does not depend upon that portion of the insulation subjected to the excessive temperature.

[e] For an electrolytic capacitor that is integral with or attached to a motor, the temperature rise on insulating material integral with the capacitor enclosure shall not be more than 65°C (117°F).

[f] A capacitor that operates at a temperature rise of more than 65°C (117°F) is capable of being judged on the basis of its marked temperature limit.

[g] Based on a 25°C (77°F) ambient temperature.

[h] Also read as Kelvin (K) degrees.

[i] Also read as Rankine (R) degrees.

40.1.2 A thermal protective device shall not operate during the Temperature Tests. See 21.6.

40.1.3 Coil and winding temperatures are to be measured by thermocouples located on exposed surfaces, except the change-in-resistance method is to be used for a coil that is inaccessible for mounting of thermocouples, such as a coil:

a) Immersed in sealing compound;

b) Wrapped with thermal insulation; or

c) Wrapped with more than two layers of material, such as cotton, paper, or rayon, having a total thickness of more than 0.8 mm (1/32 in).

In an alternating-current motor having a frame diameter of 177.8 mm (7 in) or less, the thermocouple is to be mounted on the integrally-applied (enamel) insulation of the windings.

40.1.4 Thermocouples are to consist of wires not larger than 24 AWG (0.21 mm^2). When thermocouples are used in the determination of temperatures in connection with the heating of electrical devices, the common practice is to employ thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wires and a potentiometer-type indicating instrument; such equipment is to be used whenever referee temperature measurements by thermocouples are requested.

40.1.5 When the change-in-resistance method is used, determination of the temperature rise of a winding is to be calculated by the following formula:

$$\Delta t = \frac{R_2}{R_1}(K + t_1) - (K + t_2)$$

in which:

Δt is the temperature rise in degrees C;

R_2 is the resistance of the coil in ohms at the end of the test;

R_1 is the resistance of the coil in ohms at the beginning of the test;

t_1 is the ambient temperature in degrees C at the beginning of the test;

t_2 is the ambient temperature in degrees C at the end of the test; and

K is 234.5 for copper and 225.0 for electrical conductor grade (EC) aluminum; values of the constant for other conductors are to be determined.

40.1.6 When required, the value of R at shutdown is to be determined by taking several resistance measurements at short intervals, beginning as quickly as possible after shutdown. A curve of the resistance values and the time is to be plotted and extrapolated to give the value of R at shutdown.

40.1.7 All values for temperature rises in Table 40.1 are based on an assumed ambient temperature of 25°C (77°F). However, tests are to be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F).

40.1.8 For the temperature test, the test voltage for an appliance is to be as specified in Table 35.1. An appliance rated 25 – 50 hertz or 50 – 60 hertz is to be tested using a 60-hertz supply.

40.1.9 The appliance is to be operated under each condition of normal service. For a multispeed appliance, this includes operation at each speed and, for a reversible appliance, it includes operation in each direction of rotation. When a reversible appliance continues to rotate in the same direction, but at a slower speed, when the reversing switch is thrown, the requirement applies at the lower speed as well as at the normal speed. The test is to be continued until temperatures have become constant.

40.1.10 In tests on an appliance, maximum normal load is determined to be the load that nominally represents the most severe conditions of intended use. It is not a deliberate overload except the conditions of actual use are capable of being somewhat more severe than the maximum load conditions specified by the manufacturer of the appliance. However, appliances having features not contemplated in these test procedures shall be tested as required to meet the intent of these requirements.

40.1.11 A temperature is determined to be constant when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5 minutes, indicate no further increase.

40.1.12 An appliance employing a general-use receptacle shall be loaded to the marked rating of the receptacle. The maximum length of the supply cord is to be used for the temperature test.

40.1.13 For appliances rated 12 amps or less, and that employ wiring terminals for field wiring connections, the temperature test is to be conducted with supply wiring sized for the ampacity of the appliance. When the appliance is rated more than 12 amps, the appliance is to be tested with supply wiring sized for 125 percent of the rating of the appliance.

40.2 Surface temperature

40.2.1 The temperature of a surface that the user expects to come into contact with (other than a heating function surface and an adjacent surface known to be hot because of its proximity to a heating function

surface) shall not be more than the value specified in Table 40.2 when measured in accordance with the applicable requirements in 40.1.

Table 40.2
Maximum surface temperatures[a]

Location	Composition of surface[b]	
	Metal	Nonmetallic
Handles or knobs that are grasped for lifting, carrying or holding	55°C (131°F)	75°C (167°F)
Handles or knobs that are contacted but do not involve lifting, carrying, or holding; and other surfaces subject to contact and user maintenance	60°C (140°F)	85°C (185°F)
Surfaces other than a heating function surface and known to be hot due to proximity to the heating function surface	70°C (158°F)	95°C (203°F)

[a] If the test is conducted at a room temperature of other than 25°C (77°F), the results are to be corrected to that temperature.

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

41 Dielectric Voltage-Withstand Test

41.1 An appliance shall withstand for 1 minute without breakdown the application of a 60-hertz, essentially sinusoidal, AC potential or DC potential of the value indicated in 41.2 between the following:

a) Uninsulated current-carrying metal parts and the enclosure. A non-conductive enclosure is to be wrapped in conductive foil.

b) Terminals of opposite polarity.

c) Uninsulated current-carrying metal parts and accessible dead metal parts.

d) Uninsulated current-carrying metal parts and grounding contacts of grounding type receptacles.

e) Primary and isolated secondary circuits.

41.2 The test potential referenced in 41.1 is to be as follows:

a) 1000 volts for an appliance 1/2 horsepower output or less, or an appliance without a motor and rated 51 to 250 volts. See also 20.3.4.

b) 500 volts for an appliance operating at 42.4 volts or less. See also 20.3.4.

Exception: Appliances directly connected to a Class 2 supply are not to be subjected to the dielectric voltage-withstand test.

41.3 Capacitors connected across-the-line or line-to-ground shall withstand a DC dielectric potential of 1414 volts plus 2.828 times the maximum rated supply voltage, without breakdown for 1 minute, between the terminals of the capacitor, and between the terminals and foil wrapped around the case of the capacitor.

41.4 To determine whether an appliance complies with the requirements in 41.1, it is to be tested using a 500-volt-ampere or larger capacity transformer, the output voltage of which is capable of being varied. The applied potential is to be increased from zero to the required test value and is to be held at that level for 1 minute. The increase in applied potential is to be at a substantially uniform and rapid rate while consistently maintaining the correct indication of its value by a voltmeter.

Exception: When the output of the test equipment transformer is less than 500 volt-amperes, the equipment shall include a voltmeter in the output circuit to indicate the test potential directly.

41.5 The test equipment for conducting the dielectric voltage-withstand test is to be adjusted for sensitivity such that, when a resistor of 120,000 ohms is connected across the output, the test equipment shall indicate intended performance for an output voltage that is less than (not greater or equal to) the specified test voltage. The resistance of the calibrating resistor is to be adjusted as close to 120,000 ohms as instrument accuracy can provide, but not more than 120,000 ohms.

Exception: The sensitivity of the test equipment shall not be increased, and a higher or lower value of calibrating resistance shall not be used, unless agreeable to those concerned.

41.6 An appliance employing a reversible shaded-pole motor shall withstand for 1 minute the application of a 60-hertz essentially sinusoidal potential:

a) Between the stator winding and the shading coils; or

b) Between the shading coils and the stator core, with the appliance at the temperature reached during intended use.

The value of the test potential is to be as specified in 41.2.

41.7 If the current leakage across the line, or from line to earth ground, is large enough to make continuation of the required AC test potential impossible, the appliance is to be subjected to a DC test potential of 1.414 times the applicable AC voltage. The DC test potential is to be maintained for 1 minute, except in case of breakdown.

42 Flooding of Current-Carrying Parts Test

42.1 To determine if an appliance that is provided with a container into which liquid is intended to be added by the user complies with 26.1 (a) with respect to overflow, the appliance is to be positioned as intended for normal use, cover on but fill-hole or fill-holes open. The liquid container of the appliance is to be completely filled with a salt-water solution (1/2 gram of NaCl per liter of distilled water) and a further quantity equal to 15 percent of the capacity of the container is to be poured in steadily over a period of 1 minute. When the appliance is so designed that a liquid container is situated over the motor, the spillage test is to be made with the appliance switched off or in operation, whichever imposes the more severe condition. When the liquid container is not situated over the motor, the appliance is to be operated three times in the following manner: The liquid container is to be filled with the test solution, and the appliance is to be operated at the maximum speed setting until there is no more splashing. In between operations, the appliance is to be turned off and the liquid container is to be refilled with the test solution. During this conditioning, the appliance shall comply with the Leakage Current Test, Section 36. After this conditioning, the appliance shall comply with the Dielectric Voltage-Withstand Test, Section 41.

43 Test for Deterioration of Parts Subject to Flexing

43.1 The deterioration of a part made of rubber, plastic, or a similar material, which is subject to flexing shall not result in a risk of electric shock when subjected to the test described in 43.2.

Exception: Infrequent motion of small amplitude, such as that encountered during normal operation of a diaphragm covering a pressure-operated switch, is not determined to constitute flexing as far as these requirements are concerned.

43.2 To determine whether an appliance complies with 43.1, the part subject to flexing is to be completely removed to simulate its deterioration, and the appliance is to be operated through one

complete cycle of normal operation and then subjected to the flooding test described in 42.1. The appliance shall then comply with the Leakage-Current Test, Section 36, and the Dielectric Voltage-Withstand Test, Section 41.

43.3 If an appliance does not comply with 43.2, the product shall be subjected to the testing of Section 44, Test for Reliability of Parts Not Subject to Flexing.

44 Test for Reliability of Parts Not Subject to Flexing

44.1 After the conditioning described in 44.2, a polymeric or elastomeric material used for a gasket, diaphragm, seal, or similar part, or a rubber part subject to hot soapy water during cleaning, shall have a tensile strength of not less than 75 percent and elongation of not less than 60 percent of the values determined before conditioning. At the conclusion of the tests, there shall not be visible deterioration, deformation, melting, or cracking of the material, and the material shall not harden as determined by normal hand flexing.

Exception No. 1: A material that has been investigated in accordance with 44.4 is not prohibited from having physical properties other than those specified.

Exception No. 2: A noncomposite material that has been found to comply with the requirements in the Standard for Gaskets and Seals, UL 157, and that complies with the minimum intended elongation and tensile strength after aging, is determined to be in compliance with these requirements.

Exception No. 3: A material or construction that has been investigated in accordance with 44.5 is not prohibited from having physical properties other than those specified.

44.2 A total of 20 pieces of each representative material is required for this test. Five pieces are to be tested for elongation in the as-received condition and 5 pieces are to be tested for tensile strength in the as-received condition. The 10 remaining pieces are to be placed in a circulating-air oven at a temperature of 69 – 70°C (156 – 158°F) for 168 hours. Five of the conditioned pieces are to be tested for elongation and the other 5 pieces are to be tested for tensile strength. The test methods and apparatus are described in the Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension, ASTM D412.

44.3 A gasket of material other than mentioned in 44.1, such as bonded cork or impregnated fiber, that is not known to be reliable, shall be investigated for equivalent resistance to aging and temperature. Absorptive materials, such as cork or fiber, shall not be used where they contact a current-carrying part.

44.4 To determine compliance with Exception No. 1 to 44.1, a gasket, a diaphragm, or a seal of an appliance is to be conditioned as specified in 44.2. After the oven conditioning, instead of the tensile and elongation testing, the gasket, diaphragm, or seal is then to be installed in the associated appliance and subjected to either the Flooding of Current-Carrying Parts Test, Section 42; the Tip-Over Test, Section 52; or both, for reservoir lid gaskets. As an alternate test method, entire representative appliances are to be subjected to the accelerated-aging conditioning. When an entire appliance is subjected to the accelerated-aging test, the diaphragm or seal temperature shall be monitored and maintained at the oven temperature value indicated in 44.2. The entire appliance is then to be subjected to either the Flooding of Current-Carrying Parts Test, Section 42; the Tip-Over Test, Section 52; or both, for reservoir lid gaskets.

44.5 To determine compliance with Exception No. 3 to 44.1, one representative appliance is to be tested. The liquid container's bottom seals and the motor shaft seal of the appliance are to be removed one at a time. The liquid container is then to be completely filled with a salt-water solution (1/2 gram of NaCl per liter of distilled water) while on the base of the appliance as in normal use. The test is to be conducted with the appliance either switched off or in operation, whichever imposes the more severe condition. During

this conditioning, the appliance shall comply with the Leakage Current Test, Section 36. Following this conditioning, the appliance shall comply with the Dielectric Voltage-Withstand Test, Section 41.

45 Grounding Continuity Test

45.1 The resistance between the point of connection of the appliance grounding means, at or within the equipment, and any other point in the grounding circuit shall not be more than 0.1 ohm when measured as described in 45.2.

45.2 Any instrument is capable of being used to determine whether the appliance complies with the requirement in 11.1.3.1. However, if unacceptable results are recorded as determined by the condition described in 45.1, an alternating-current of at least 25 amperes from a power supply of not more than 12 volts is to be passed from the point of connection of the appliance grounding means to a point in the grounding circuit, and the resulting drop in potential is to be measured between the two points. The resistance in ohms is to be determined by dividing the drop in potential in volts by the current in amperes passing between the two points. The grounding conductor of a supply circuit cord is not to be tested by the latter method.

46 Tests on Switches and Controls

46.1 A switch or other device that controls a motor of an appliance, a solenoid, a relay coil, or similar component shall exhibit intended performance when subjected to an overload test consisting of 50 cycles of operation as described in 46.2 – 46.4. There shall be no electrical or mechanical malfunction or breakdown of the device or undue burning or pitting of the contacts, and the fuse in the grounding connection shall not open.

Exception No. 1: This requirement does not apply to a device known to meet the requirement of the component standard and to be properly rated for the application.

Exception No. 2: A device interlocked so that it is not capable of breaking the locked-rotor motor current is not required to be tested.

46.2 Exposed dead metal parts of the appliance are to be connected to ground through a 3-ampere plug fuse, and the appliance is to be connected to a grounded supply circuit of rated frequency. During the test, the device is to be operated at a rate of not more than 10 cycles per minute, except that a faster rate of operation also meets the intent of the requirement if agreeable to those concerned.

46.3 When testing a switch or other control device that controls a solenoid, a relay coil or similar components, the appliance is to be connected to a supply circuit of rated frequency and 110 percent of maximum rated voltage. The load on the device being tested is to be the same as that which it is intended to control in normal service.

46.4 When testing a switch or other control device that controls a motor, the rotor of the motor is to be locked in position and the appliance is to be connected to a supply circuit of maximum rated voltage. See 40.1.4. The connection is to be such that any single-pole, current-interrupting device will be located in the 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 exposed dead metal parts of the appliance are to be connected so as to be positive with respect to a single-pole, current-interrupting control device.

47 Strain-Relief Test

47.1 The strain relief means provided on a flexible cord shall withstand for 1 minute without displacement a direct pull of 155.68 N (35 lb) applied to the cord, with the connections within the appliance disconnected. The strain relief does not meet the intent of the requirements when, at the point of

disconnection of the conductors, there is such movement of the cord as to indicate that stress on the connections has resulted.

Exception: The strain relief means provided in a through-cord switch shall be in accordance with the requirements of 47.3.

47.2 A 16-kg (35-lb) weight is to be suspended from the cord and supported by the appliance so that the strain-relief means is able to be stressed from any angle without interference from the construction of the appliance.

47.3 The strain relief means provided in a through-cord switch shall withstand for 1 minute a direct pull of 133.44 N (30 lb). The strain relief is not acceptable when a conductor becomes detached from a terminal or an uninsulated conductor of the cord is exposed.

47.4 For the construction mentioned in 11.1.2.3, each of six representative clamps that have been secured to the cord in the intended manner is to be used. One group of three clamps is to be subjected to the Dielectric Voltage-Withstand Test, Section 41, and shall then comply with the strain-relief test specified in 47.1 in the as-received condition. The other group of three clamps shall comply with the requirements specified in 47.1 after being subjected to the following procedures:

a) Each test clamp is to be placed for 168 hours in a forced-draft, air-circulating oven maintained at a temperature of 70°C (158°F) or 10°C (18°F) higher than the temperature recorded on the clamp during the Temperature Test, Section 40, whichever is greater.

b) Each test clamp is then to be subjected to the Dielectric Voltage-Withstand Test, Section 41, with the value of the applied potential based on the rating of the appliance. The potential is to be applied between conductors, and the potential is also to be applied between the clamp and all conductors spliced together.

c) Each conditioned test clamp is then to be cooled at room temperature.

48 Abnormal Operation Test

48.1 In a combination consisting of a rectifier and an electrolytic capacitor, short-circuiting either the rectifier or the capacitor shall not create a risk of fire, electric shock, or injury to persons.

48.2 As required by 32.1, an appliance shall be subjected to the abnormal operation test as specified in 48.3 – 48.16.

48.3 With reference to 48.2, a risk of fire or electric shock is determined to exist when any of the following occur:

a) Glowing, charring, or flaming of the cheesecloth or tissue paper as specified in 48.7;

b) Opening of the 3-amp fuse specified in 48.8;

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

d) Creation of any openings in the enclosure that results in accessibility of current-carrying parts, when judged in accordance with Accessibility of Current-Carrying Parts, Film-Coated Wire, and Moving Parts, Section 10; and

e) Loss of structural integrity to a degree that the appliance collapses or experiences displacement of parts that leads to short-circuiting or grounding of current-carrying parts.

48.4 The circuit between any two terminals of a device is to be opened or shorted. Only one of the simulated fault conditions is to be imposed at a time. For a multi-terminal device, only two terminals are to be short-circuited at a time. Use of simulated circuits is not prohibited but when the tests performed on simulated circuits indicate damage to other parts of the appliance, to the extent that the safety of the appliance is affected, the tests shall be repeated on the appliance.

48.5 Each test is to be conducted on a separate unit unless it is agreeable to those concerned that more than one test be conducted on the same unit.

48.6 A part of the appliance that is removed during routine operation or maintenance is to be omitted when it results in a more severe test, and the part is not:

a) Required for the functioning of the equipment; and

b) Exposed to view during intended operation.

Exception: The part is not required to be removed during testing when it can only be removed by the use of a tool.

48.7 During these tests, the appliance is to be placed on a softwood surface covered with white tissue paper, and a single layer of cheesecloth is to be draped loosely over the entire enclosure.

Exception No. 1: Appliances not having bottom openings are not required to be placed on a softwood surface covered with white tissue paper.

Exception No. 2: When draping the entire enclosure is not practical, cheesecloth is to be placed only over all ventilating openings.

48.8 During each test, exposed dead-metal parts of the appliance are to be connected to earth ground through a 3-amp, non-time-delay fuse.

48.9 The supply circuit is to have branch circuit overcurrent protection, the size of which equals 125 percent of the input current rating (20-amp minimum). When this value does not correspond with the standard rating of a fuse or a circuit breaker, the next higher standard device rating shall be used. The test voltage and frequency are to be adjusted to the maximum rated voltage of the appliance.

Exception: When a marking on the fan or the manufacturer's literature indicates the use of branch circuit protection exceeding 125 percent of the input current, such protection shall be used.

48.10 A fuse that is replaced during routine maintenance is to be defeated unless marked in accordance with 72.1.11. A fuse that is soldered in place (or is located such that it is accessible only to qualified service personnel) and marked in accordance with 72.1.11, as well as any other overcurrent protective device not subject to replacement during routine maintenance, is to be left in the circuit.

48.11 Each abnormal condition is to be conducted for 7 hours or until one or more of the following results are observed:

a) A risk of fire or electric shock develops (see 48.3);

b) The branch-circuit fuse opens;

c) The supplementary protective device opens:

d) A minimum of one hour elapses, circuit conditions stabilize, and there is no further evidence of overheating of parts.

48.12 The overheating of parts referred to in 48.11(d) is to be detected by an indicator, such as an odor, smoke, discoloration, cracking of materials, charring, flaming, glowing, arcing, changes in circuit current through the applied fault, or any similar phenomenon.

48.13 When a fault condition is terminated by the opening of a circuit component, the test is to be conducted two more times using new components for each test.

48.14 When tested in accordance with 48.15, there shall not be:

a) Ignition of the mounting surface or the cheesecloth as a result of emission of glowing or flaming materials;

b) Ignition of enclosure; or

c) Access to current-carrying parts.

In addition, the appliance shall comply with the Dielectric Voltage-Withstand Test, Section 41.

48.15 The appliance is to be operated under the various conditions of abnormal operation, such as stalled-rotor operation at different speed settings. During the test, the appliance is to be draped with one layer of cheesecloth while resting on white tissue paper on a soft wood surface and operated continuously until the ultimate results have been determined. In most cases, continuous operation for 7 hours will be required in order to make sure that the ultimate results have been determined. Warping, breakage, expansion, or cracking of the enclosure material meets the intent of the requirement if current-carrying parts are not exposed.

48.16 A single malfunction (short or open) of any circuit component, such as a resistor, capacitor, solid state device, and the like shall not result in a risk of fire or electric shock or increased risk of personal injury. For a discrete, multiple (more than two) terminal device, such as a transistor, SCR, triac or an integrated circuit device, any combination of terminals taken two at a time shall be open- or short-circuited.

Exception: Abnormal operation testing of multiple terminal circuit devices may be reduced if it can be determined by circuit analysis that an open- or short-circuit of the termianl(s) is not likely to result in a risk of fire, electric shock, or injury to persons.

49 Operational Test

49.1 Operation, as described in 49.2, of an appliance intended for household use shall not increase the risk of fire, electric shock, or injury to persons.

49.2 An as-received, representative appliance is to be set up or installed in accordance with the manufacturer's instructions. The appliance is to be operated in accordance with the manufacturer's instructions with respect to the intended uses of the appliance, including maintenance and cleaning recommended by the manufacturer, and with all accessories recommended by the manufacturer for use with the appliance. The appliance is to be manipulated as if it is in actual use, including manipulation of all controls and operation under the various loading conditions that can be expected. The appliance is to be operated for a sufficient length of time or through a sufficient number of cycles to determine that all reasonably foreseeable complications are revealed.

50 Permanence of Marking Test

50.1 Unless specifically excepted, all marking required in the Standard shall be permanent. Ink-printed and stenciled markings, and decalcomania and pressure-sensitive labels are among the types of markings

that are able to be used. Pressure-sensitive labels and labels secured by cement or adhesive shall comply with 50.1 – 50.6 or the Standard for Marking and Labeling Systems, UL 969.

50.2 After being subjected to the conditions described in 50.3 – 50.6, and immediately following removal from each test medium and after being exposed for 24 hours to room temperature following removal from each medium, a pressure-sensitive label or a label secured by cement or adhesive that does not comply with the Standard for Marking and Labeling Systems, UL 969, shall:

a) Demonstrate good adhesion and not have curled edges;

b) Resist defacement or removal, as demonstrated by scraping across the test panel with a flat metal blade 0.8 mm (1/32 in) thick held at right angles to the test panel and scraped across the test panel ten times with a force of 2 lb (900 g); and

c) Be legible and resist defacement when rubbed with thumb or finger pressure.

50.3 IMMERSION TEST – Each of three representative labels applied to test surfaces in the intended application is to be conditioned for 24 hours in a controlled atmosphere maintained at a temperature of 23 ±2°C (73 ±4°F) with a relative humidity of 50 ±5 percent. The labels are then to be immersed for 48 hours in water at a temperature of 21 ±2°C (69.8 ±3.6°F).

50.4 OVEN-AGING TEST – Each of three representative labels applied to test surfaces in the intended application is to be conditioned for 240 hours in an air-oven maintained at the temperature specified in Table 50.1.

Table 50.1
Air-oven aging temperatures

Maximum normal operating temperature of surface of applied label in °C (°F)	Air oven test temperature	
	°C	(°F)
60 (140)	87	(189)
80 (176)	105	(221)
100 (212)	121	(250)
125 (257)	150	(302)
150 (302)	180	(356)
Greater than 150 (302)	a	a

[a] A label that is applied to a surface attaining a temperature greater than 150°C (302°F), during the Temperature Test, Section 40, is to be oven-aged at a temperature representative of the temperatures attained by the appliance during all anticipated conditions of operation.

50.5 STANDARD-ATMOSPHERE TEST – Each of three representative labels applied to test surfaces in the intended application is to be conditioned for 72 hours in a controlled atmosphere maintained at a temperature of 23 ±2°C (73.4 ±3.6°F) with a relative humidity of 50 ±5 percent.

50.6 UNUSUAL-CONDITION EXPOSURE TEST – If the labels are exposed to unusual conditions in service (such as oil, grease, or similar agents), each of three representative labels applied to test surfaces in the intended application is to be conditioned for 24 hours in a controlled atmosphere maintained at a temperature of 23 ±2°C (73.4 ±3.6°F) with a relative humidity of 50 ±5 percent. The labels are then to be immersed for 48 hours in a solution representative of service use, and maintained at the temperature the solution attains in service but not less than 23 ±2°C (73.4 ±3.6°F).

51 Stability Test

51.1 If a portable appliance overturns when tested as described in 51.2 and 51.4, a risk of injury to persons shall not result.

51.2 The appliance is not to be energized during the stability test. The test is to be conducted under conditions that increase the risk of the appliance overturning. The following conditions are to be such as to result in the least stability:

a) Position of all doors, drawers, casters, and other movable or adjustable parts, including that of the supply cord resting on the surface supporting the appliance;

b) Connection of or omission of any attachment made available or recommended by the manufacturer;

c) Provision of or omission of any normal load if the appliance is intended to contain a liquid or other mechanical load; and

d) Direction in which the appliance is tipped or the supporting surface is inclined.

51.3 In conducting the stability test, the appliance is to be:

a) Placed on a plane inclined at an angle of 10 degrees from the horizontal; or

b) Tipped through an angle of 10 degrees from an at-rest position on a horizontal plane.

51.4 While being tipped as stated in 51.3(b), an appliance that is constructed so that a part or surface of the appliance not normally in contact with the horizontal supporting surface touches the supporting surface before the appliance has been tipped through an angle of 10 degrees, the tipping is to be continued until the surface or plane of the surface of the appliance originally in contact with the horizontal supporting surface is at an angle of 10 degrees from the horizontal supporting surface.

52 Tip-Over Test

52.1 Each of three representative units of an appliance, as described in Hot Liquids, clause 34.6, is to be tested three times. Each appliance is to be placed on a horizontal surface of laminated, thermosetting counter-top-type material. The appliances are to be oriented in a position that is expected to occur during intended use, and are to contain whatever combination of separable components and liquid that results in the most adverse condition for this test.

52.2 For an appliance with a liquid capacity of 947 ml (32 fluid ounces) or less, the unit is to be tilted to determine its critical angle of balance (the angle at which the unit will tip over due only to the force of gravity). The results are acceptable if one of the following occurs:

a) The critical angle of balance is 45 degrees or greater; or

b) The lid, if provided, remains in place and the amount of liquid emitted during the first 5 seconds from the appliance during tip-over is no more than 148 ml (5 fluid ounces).

Exception: An appliance having a reservoir with a liquid capacity of 148 ml (5 fluid ounces) or less is not required to be tested.

52.3 For an appliance with a capacity of greater than 947 ml (32 fluid ounces), the unit is to be tipped over. The results are acceptable if the lid remains in place and the amount of fluid emitted during the first 5 seconds is no more than 147 ml (5 fluid ounces).

53 Consumables

53.1 Flash point test

53.1.1 In accordance with 28.3, the flash point test for a liquid fragrance shall not ignite or flashover when tested in accordance with any one of the following standards:

a) Tests For Comparative Flammability of Liquids, UL 340;

b) Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester, ASTM D93;

c) Standard Test Method for Flash Point by Continuously Closed Cup (CCCFP) Tester, ASTM D6450;

d) Standard Test Method for Flash Point by Modified Continuously Closed Cup (MCCCFP) Tester, ASTM D7094; or

e) Standard Test Methods for Flash Point by Small Scale Closed Cup Tester, ASTM D3828.

53.2 Flame ignition test

53.2.1 If the wick provided in an appliance utilizing a liquid fragrance reaches a temperature greater than 30°C (54°F) below the flash point of the fragrance, during normal operation, the flame ignition test is to be conducted. The complete unit and the fragrance being investigated shall be placed in the test fixture, as shown in Figure 53.1 and Figure 53.2. The test fixture shall be placed in a draft-free hood. The unit is to be energized and operated in the test fixture until a stable temperature is obtained. Once stability is established, the unit shall continue to be operated for 3.5 hours. At the conclusion of the 3.5-hour period, a spark shall be generated in the test fixture.

Figure 53.1

Test fixture for flame ignition – external view