UL 1431

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Personal Hygiene and Health Care Appliances

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UL Standard for Safety for Personal Hygiene and Health Care Appliances, UL 1431

Second Edition, Dated November 22, 1996

Revisions: This Standard contains revisions through and including March 26, 2007.

SUMMARY OF TOPICS

This revision to UL 1431 includes the addition of an Exception to 71.1.2 to allow floor mounted air blower type hydromassagers to use SPT-2, NISPT-2, or SVT type power supply cords.

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Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revised requirements are substantially in accordance with UL's Proposal(s) on this subject dated February 2, 2007.

The revisions dated March 26, 2007 include a reprinted title page (page1) for this Standard.

The revisions dated May 23, 2006 editorially replace all references to UL 1020 with the reference to UL 60691.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: http://ulstandardsinfonet.ul.com/ulforeword.html

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

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New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if

the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

This Standard consists of pages dated as shown in the following checklist:

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NOVEMBER 22, 1996
(Title Page Reprinted: March 26, 2007)

1

UL 1431

Standard for Personal Hygiene and Health Care Appliances

First Edition – August, 1984

Second Edition

November 22, 1996

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements. 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 http://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover household electric products having personal hygienics or health care applications, such as hydromassage units, contact lens disinfectors and cleaners, and toothbrushes, rated at 250 V or less, for use on premises wiring systems in accordance with the National Electrical Code.

1.2 These requirements do not cover professional medical and dental equipment, electrically heated pads, facial units, sun and heat lamps, permanently-installed whirlpool baths, spas and hot tubs, shavers, hair dryers, steam and dry heat cabinets or other equipment or products that are covered by separate, individual requirements separate from this Standard.

1.3 The requirements of this Standard do not consider the complete spectrum of physiological or therapeutic effects, beneficial or otherwise, except where generally recognized limits for conditions where a potential risk of injury to persons are defined.

1.4 *Deleted August 6, 2004*

2 Glossary

2.1 For the purpose of this Standard, the following definitions apply.

2.2 ACCESSIBLE PART – A part located so that it can be contacted by a person, either directly or by means of a probe or tool during user servicing, or that is not recessed the required distance behind an opening.

2.3 BASIC INSULATION – The insulation applied to live parts to provide basic protection against electric shock. Basic insulation does not necessarily include insulation used exclusively for functional purposes.

2.4 DOUBLE INSULATION – An insulation system comprised of basic insulation and supplementary insulation, with the two insulations physically separated and so arranged that they are not simultaneously subjected to the same deteriorating influences (temperature, contaminants, and the like) to the same degree. See 2.3, 2.13, and 2.16.

2.5 ENCLOSURE – An external portion of a product that serves to house or support component parts or both.

2.6 ENERGIZED (LIVE) PART – A part energized with respect to some other part or with respect to earth.

2.7 FIELD-WIRING TERMINAL – Any terminal to which a supply or other wire is to be connected by an installer is a field-wiring terminal. If the wire, to be connected to the terminal, is provided as part of the unit and a pressure terminal, connector, soldering lug, soldered loop, crimped eyelet, or other means for making the connection is factory-assembled to the wire, it is not a field wiring terminal.

2.8 INTERLOCK – A device used to de-energize electrical components or stop moving parts that become exposed when an enclosure is opened or when a cover is removed.

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

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

a) The circuit potential on the load side of the limiting impedance does not exceed 42.4 V peak (the peak voltage of a 30-V sine wave), under normal conditions, and

b) The maximum energy available at the load side of the limiting impedance circuit is 15 VA under any condition, including abnormal operation.

2.11 LOW VOLTAGE CIRCUIT – A circuit involving an open circuit potential of not more than 42.4 V peak (the peak voltage of a 30-V sine wave) supplied by a primary battery, by a standard Class 2 transformer, or by a combination of a transformer and fixed impedance that, as a unit, complies with all performance requirements for Class 2 transformers.

2.12 OPERATOR (USER) SERVICING – Any form of servicing that might be performed by personnel other than qualified service personnel. Some examples are:

a) The attachment of accessories by means of attachment plugs and receptacles or by means of other separable connectors not involving disassembly or use of tools.

b) Resetting of circuit breakers or replacement of fuses, and lamps that are accessible without the use of tools.

c) Routine operating adjustments necessary to adapt the product for its different intended functions.

d) Routine cleaning and changing of filters.

2.13 REINFORCED INSULATION – Improved basic insulation with such mechanical and electrical qualities that it, in itself, provides the same degree of protection against electric shock as double insulation.

2.14 SAFETY CIRCUIT – Any circuit, either in the primary or secondary, that is relied upon to reduce the risk of fire, electric shock, or unintentional contact with moving parts, for example, an interlock circuit is considered to be a safety circuit.

2.15 SECONDARY CIRCUITS – Secondary circuits are those circuits supplied from transformer output windings that are electrically separated from the input windings.

2.16 SUPPLEMENTARY (PROTECTING) INSULATION – An independent insulation provided in addition to the basic insulation to protect against electrical shock in case of mechanical rupture or electrical breakdown of the basic insulation.

2.17 HYDROMASSAGE UNITS – For the purpose of this Standard, hydromassage units are considered to be two types:

Water Pump Type – A unit that agitates the bath water by having its moving parts in direct contact with the water, is considered to be of the water pump type.

Air Blower Type – A unit that agitates the bath water by means of air that is generated by the unit, and whose moving parts do not come in contact with the water, is considered to be of the air blower type.

3 Components

3.1 Except as indicted in 3.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

3.1 revised August 2, 2000

3.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

3.2 revised August 2, 2000

3.3 A component shall be used in accordance with its rating established for the intended conditions of use.

3.3 revised August 2, 2000

3.4 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.

3.4 revised August 2, 2000

4 Units of Measurement

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

4.2 revised August 2, 2000

5 References

5.1 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.

6 General

6.1 Requirements in this Standard apply generally to all personal hygiene and health care products and are supplemented by requirements for specific products. Throughout these requirements, the term ″product″ is used broadly to refer to any personal hygiene and health care product and its associated control assembly.

CONSTRUCTION

7 General

7.1 A container for liquid intended for use with the product, and supplied as part of the product, shall comply with applicable construction requirements.

8 Frame and Enclosure

8.1 The frame and enclosure of a product shall have the strength and rigidity necessary to resist the abuses likely to be encountered during intended service. The degree of resistance inherent in the product shall preclude total or partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other conditions which alone or in combination constitute an increase in the risk of fire, electric shock, or injury to persons.

8.2 A risk of fire is considered to exist at a component part or assembly if an investigation shows that the supply for such part or assembly is capable of delivering a power of more than 15 W into an external resistor connected between the point in question and any return to the power supply.

8.3 A risk of electric shock is considered to exist at parts accessible only to the user or operator during intended use or user servicing if the voltage exceeds 42.4 V peak (the peak voltage of a 30-V sine wave) and the available current exceeds the leakage current levels specified in Leakage Current Test, Section 43.

8.4 Among the factors taken into consideration in determining the acceptability of an enclosure are its:

a) Physical strength,

b) Resistance to impact,

c) Moisture absorptive properties,

d) Combustibility,

e) Resistance to corrosion, and

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

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

8.5 A polymeric enclosure shall comply with the applicable requirements in Section 4, Enclosures – General, in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. A polymeric enclosure used in the construction of cord connected equipment that is fixed or permanently installed to the building structure, such as plumbing, shall have a flammability rating of 5VA in accordance with UL 746C.

8.5 revised August 6, 2004

8.6 The minimum thickness of a metal enclosure shall be as indicated in Table 8.1.

8.7 An electrical part of the product shall be so located or enclosed that protection against unintentional contact with any uninsulated live part and internal wiring will be provided.

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

8.9 In connection with the requirements in 8.7, a part of the outer enclosure that may be removed without the use of a tool – to provide for the attachment of accessories, to allow access to means for making operating adjustment, or for another reason – is to be disregarded. It will not be assumed that the part in question affords protection against risk of electric shock.

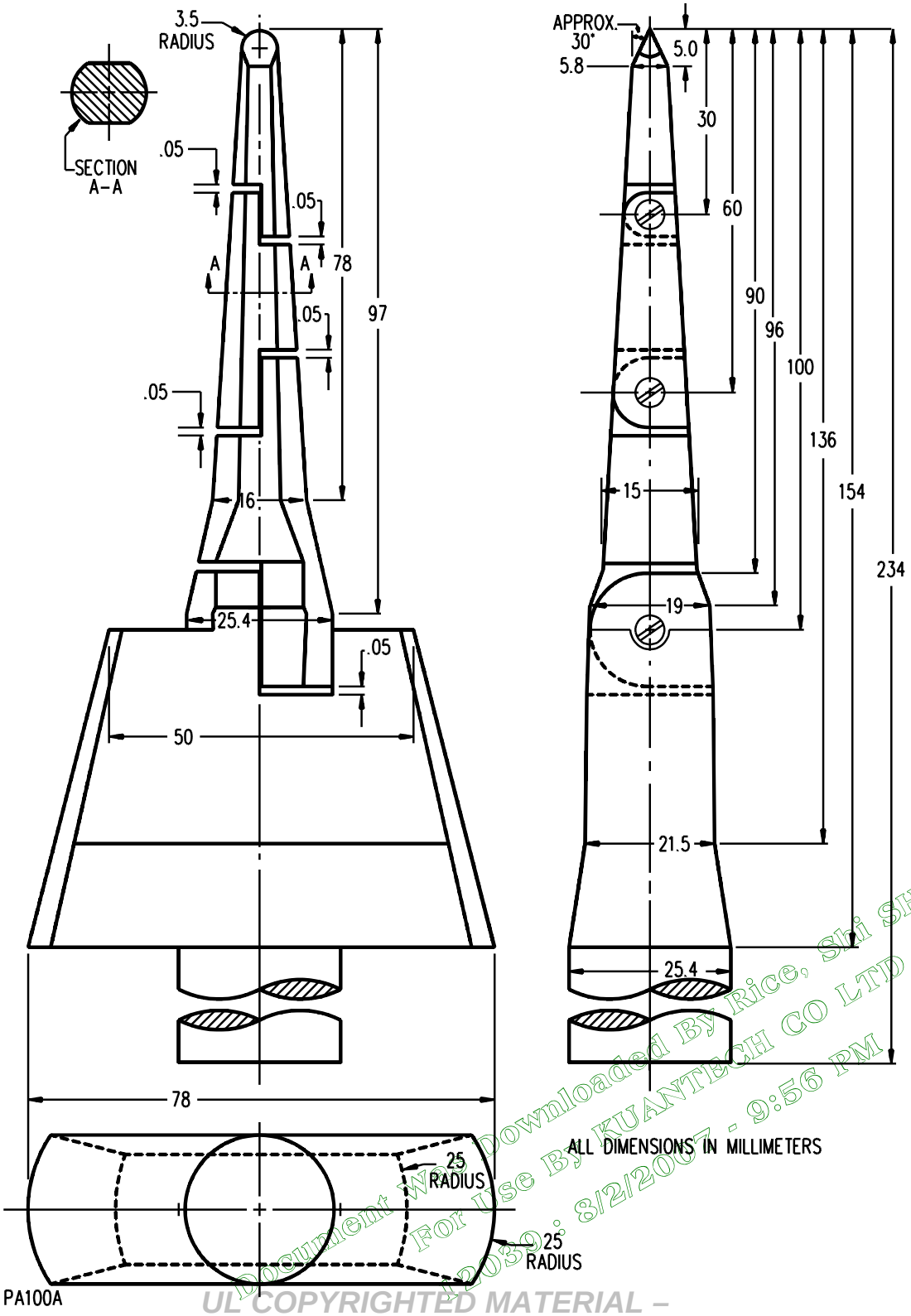
8.10 In the enclosure of a product, an opening that a 1 inch (25.4 mm) diameter rod will not enter is acceptable if a probe as illustrated in Figure 8.1 cannot be made to touch any part that involves a risk of electric shock to earth ground when inserted through the opening.

Table 8.1
Minimum acceptable thicknesses of enclosure material

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

[a] Thinner sheet metal may be employed if found to be acceptable when the enclosure is evaluated under considerations such as those mentioned in 8.4.

Figure 8.1
Accessibility probe



8.11 With respect to the application of the requirement of 8.10, the probe may be articulated into any configuration and may be rotated or angled to any position before, during, or after insertion into the opening, and the penetration may be to any depth allowed by the opening size, including minimal depth combined with maximal articulation.

8.12 An opening that has a minor dimension of 1 inch (25.4 mm) or more, in an enclosure, as illustrated in Figure 8.2, is acceptable if, within the enclosure, there is no uninsulated live part or film-coated wire, that involves a risk of electric shock, less than, R distance from the inside edge of the perimeter of the opening and X distance from the plane of the opening. T equals the enclosure thickness, R equals X minus T, and X equals five times the diameter of the largest round rod that can be inserted through the opening but not less than 6-1/16 inches (154 mm). In evaluating an opening, any barrier located within the volume is to be ignored unless it intersects the boundaries of the volume in a continuous, closed line.

8.13 Insulated brush caps do not require additional enclosure.

8.14 The enclosure of a remotely or automatically controlled product shall not permit molten metal, burning insulation, flaming particles, or the like from falling on combustible materials, including the surface upon which the product is supported.

8.15 A product is automatically controlled under any one or more of the following conditions:

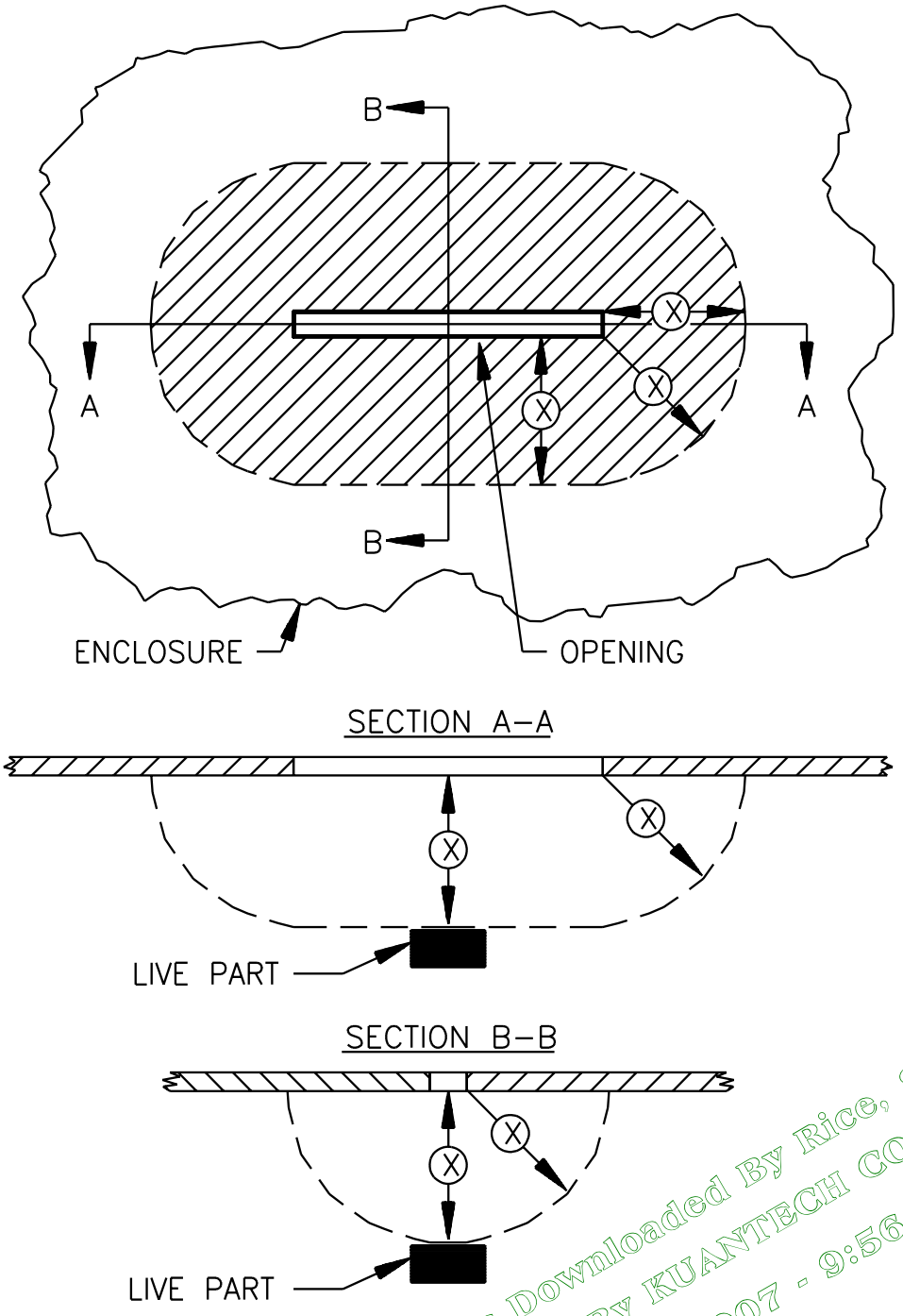
a) If the repeated starting of the product, beyond one complete predetermined cycle of operation, to the point where some form of limit switch opens the circuit, is independent of any manual control.

b) If, during any single predetermined cycle of operation, the motor is caused to stop and restart.

c) If, upon energizing the product, the initial starting of the motor may be intentionally delayed beyond conventional starting.

d) If, during any single predetermined cycle of operation, automatic changing of the mechanical load may reduce the motor speed sufficiently to reestablish starting-winding connections to the supply circuit.

Figure 8.2
Opening in enclosure



Proportions exaggerated for clarity

8.16 The requirement in 8.14 will necessitate the use of a barrier of material that is resistant to combustion:

a) Under a motor unless:

1) The structural parts of the motor or of the product 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 product when the motor is energized under each of the following fault conditions:

i) Main winding opened,

ii) Starting winding opened,

iii) Starting switch short circuited, and

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

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

b) Under wiring, unless it is neoprene- or thermoplastic-insulated.

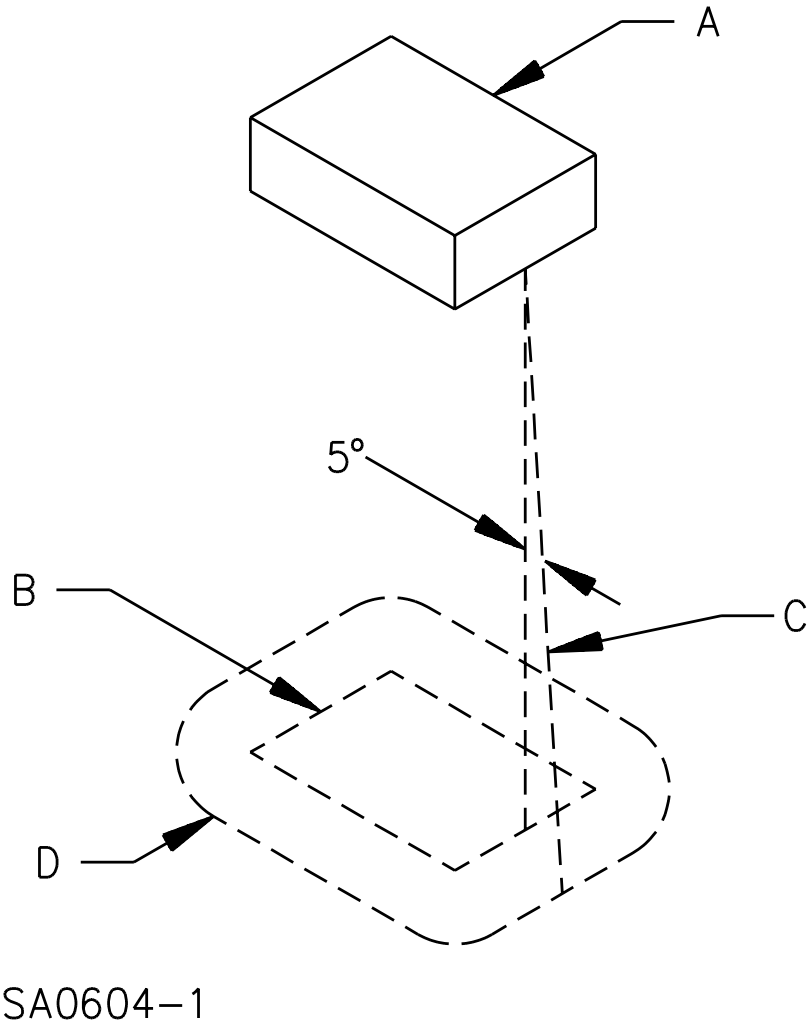
It will also necessitate that a switch, relay, solenoid, or the like be individually and completely enclosed unless there is no opening in the bottom of the product enclosure, or it can be shown that malfunction of the component would not result in a risk of fire.

Exception: Terminals of a switch, relay, solenoid or the like need not be individually and completely enclosed.

8.17 The barrier mentioned in 8.16 shall be horizontal, shall be located as indicated in Figure 8.3, and shall not have an area less than that described in that illustration. An opening for drainage, ventilation, and the like may be employed in the barrier, provided that such an opening would not permit molten metal, burning insulation, or the like to fall on combustible material.

Figure 8.3
Location and extent of barrier

Figure 8.3 revised August 4, 1998



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

B – Projection of outline of component on horizontal plane.

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

1) Tangent to the component,

2) 5 degrees from the vertical, and

3) 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.

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

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

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9 Mechanical Assembly

9.1 The assembly of a product that involves a motor or other vibrating unit shall be such that the product will not be affected adversely by the vibration of intended operation. Brush caps shall be tightly threaded or otherwise so constructed as to keep them from loosening.

9.2 A switch, a lampholder, a receptacle, a motor-attachment plug, or similar component shall be mounted securely, and shall be kept from turning.

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

a) The switch is of the plunger or other type that does not tend to rotate when operated — a toggle switch is considered to be subject to forces that tend to turn the switch during intended operation of the switch.

b) The means of mounting the switch is such that the operation of the switch is unlikely to result in the switch becoming loosened.

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

d) Intended operation of the switch is by mechanical means rather than by direct contact by persons.

Exception No. 2: A lampholder of the type in which the lamp cannot be replaced, such as a neon pilot or indicator light in which the lamp is sealed in by a nonremovable jewel, need not be kept from turning if the rotation cannot reduce spacings below the minimum acceptable values.

9.3 The means to keep a device from turning mentioned in 9.2 is to include more than friction between surfaces. For example, a lockwasher, properly applied, is acceptable as a means to prevent turning of a device having a single-hole mounting means.

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

10 Protection Against Corrosion

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

Exception No. 1: In certain instances in which the oxidation of iron or steel due to the exposure of the metal to air and moisture is not likely to be appreciable – thickness of metal and temperature also being factors – surfaces of sheet steel within an enclosure may not be required to be protected against corrosion. The requirement does not apply to bearings, laminations, or minor parts of iron or steel, such as washers, screws, and the like.

Exception No. 2: Cast-iron parts are not required to be protected against corrosion.

Exception No. 3: The sheath of a heating element operating in air and terminal parts attached directly to the heating element need not be protected against corrosion. The sheath of an immersion type heating element shall be of a metal resistant to corrosion resulting from the liquid in which the element is intended to be immersed.

10.2 A container for liquid shall be protected against the possible corrosive effect of the liquid intended to be used in the container.

11 Supply Connections

11.1 Permanently connected products

11.1.1 General

11.1.1.1 A permanently connected product – a product intended for permanent connection to the power supply – shall have provision for connection to the wiring systems that, in accordance with the National Electrical Code, ANSI/NFPA No. 70, would be acceptable for the product.

11.1.1.2 A product intended for permanent attachment to the building structure, water or steam supply, drains, and the like shall be provided with a means for permanent connection to the branch-circuit supply.

11.1.1.3 A product that is not actually moved or easily moved in intended use, but which is not obviously intended to be permanently connected, may be acceptable if provided with the shortest feasible length of Type SJE, SJT, SJO, or equivalent cord and an attachment plug for supply connection. The investigation of such feature will include consideration of the utility of the product and the necessity of having it readily detachable from its source of supply by means of the plug.

11.1.1.4 The location of a terminal or splice compartment in which power supply connections to a permanently connected product are to be made shall be such that these connections may be readily inspected after the product is installed as intended.

11.1.1.5 The compartment mentioned in 11.1.1.6 shall be so located that during conduit connections thereto, internal wiring and electrical components are not exposed to physical abuse or strain.

11.1.1.5 revised August 2, 2000

11.1.1.6 A terminal compartment intended for connection to a supply raceway shall be attached to the product so that it will not turn with respect thereto.

11.1.1.7 A compartment or part of an enclosure that contains field wiring splices other than low-voltage circuits (see 2.11) shall not be provided with ventilating openings.

11.1.2 Wiring terminals

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

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

Exception: A wire binding screw may be employed at a wiring terminal intended to accommodate a 10 AWG (5.26 mm^2) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in position.

11.1.2.2 revised August 6, 2004

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

11.1.2.4 A wire-binding screw at a wiring terminal shall not be smaller than No. 10.

Exception: A No. 8 screw may be used at a terminal intended only for the connection of a 14, 16, or 18 AWG (2.08, 1.31, or 0.82 mm^2) conductor, and a No. 6 screw may be used for the connection of a 6 AWG or 18 AWG control-circuit conductor.

11.1.2.4 revised August 6, 2004

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

Exception: A plate less than 0.050 inch thick, but not less than 0.030 inch (0.76 mm) thick is acceptable if the tapped threads have acceptable mechanical strength.

11.1.2.6 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned in 11.1.2.1, but not smaller than 14 AWG (2.08 mm^2), under the head of the screw or the washer.

11.1.2.6 revised August 6, 2004

11.1.2.7 A wire binding screw shall thread into metal.

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

11.1.2.9 A lead intended for the connection of a grounded circuit conductor shall be finished to show a white or gray color and shall be readily distinguishable from the other leads.

11.1.2.9 revised August 6, 2004

11.1.2.10 The free length of a lead inside an outlet box or wiring compartment shall be 6 inches (152.4 mm) or more if the lead is intended for field connection to an external circuit.

Exception: A lead may be less than 6 inches in length if it is evident that the use of a longer lead might result in a risk of fire, electric shock or injury to persons.

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

11.1.2.12 A wire binding screw intended for the connection of an equipment grounding conductor shall have a green colored head that is hexagonal shaped, slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified as such by being marked ″G,″ ″GR,″ ″GND,″ ″Grounding″ or the like or by a marking on the wiring diagram provided on the product. The wire binding screw or pressure wire connector shall be so located that it is unlikely to be removed during the normal servicing of the product other than the grounding conductor.

11.1.2.13 A terminal solely for connection of an equipment grounding conductor shall be capable of securing a conductor of the correct size for that purpose. A quick-connect terminal or a solder lug shall not be used for the grounding terminal.

11.2 Cord- and plug-connected products

11.2.1 Cords and plugs

11.2.1.1 A product intended for cord connection shall be provided with 6 – 8 feet (1.83 – 2.44 m) of flexible cord and an attachment plug for connection to the supply circuit. The cord length is measured from the point of cord entry into the enclosure, or into the wiring device at the product end of the cord, to the face of the attachment-plug.

Exception: Cord length may vary for certain types of products, as specified in Table 11.1.

Table 11.1
Cord lengths for specific conditions

Type of product	Cord length feet (m)	
	Minimum	Maximum
Product supported by hand, table top, or counter top	4 (1.22)	8 (2.44)
Any product having a jacketed cord	a	not specified
Product secured in place such as toilet seat assemblies	2 (0.61)	4 (1.22)

[a] As specified elsewhere in this table or in 11.2.1.1.

11.2.1.2 The flexible cord:

a) May be permanently attached to the product, or

b) For other than a hand supported product, may be in the form of a detachable power supply cord with means for connection to the product.

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

11.2.1.4 The flexible cord shall be of a type indicated in Table 11.2 or shall have properties such that it will be at least equally as serviceable for the particular application.

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Table 11.2
Acceptable types of cord and applicable limitations on their use

Product on which the cord in to be used	Cords acceptable where temperature higher than 121°C (250°F) are attained on any surface the cord can touch	Cords acceptable where 121°C (250°F) or lower temperatures are attained on any surface the cord can touch
Contact Lens Disinfector and similar table top (counter top) products	HPN, HSJ, HSJO	SP-2, SPE-2, SPT-2, SV, SVE, SVO, SVT, SVTO, SJ, SJE, SJO, SJT, SJTO, SP-1[a], SPE-1[a], SPT-1[a]
Charger Units for battery operated toothbrushes, and the like; Denture Cleaners and Oral Irrigation Products		SPE-1, SP-1, SPT-1
Toothbrushes		TP or TPT (maximum 50 W), SP-1, SJE-1 or SPT-1, XT (parallel 2-conductor construction required)
Oxygen Enrichers and similar Floor Mounted Devices		SJ, SJE, SJO, SJT, SJTO
Toilet Seat Assemblies		SVE, SVO, SVT, SVTO, SJ, SJE, SJO, SJT, SJTO

[a] Acceptable on table-supported products weighing 1/2 lb (0.023 kg) or less.

11.2.1.5 Type SPT-2, SVT, or other flexible cord at least as serviceable may be used for connecting a pendant-type on-off switch, a temperature control or both to a table- or floor-supported product.

11.2.1.5.1 The attachment plug of the power supply cord of an appliance provided with:

a) A manually operated, line-connected, single pole switch for appliance on-off operation or

b) An Edison-base lampholder,

shall be of the polarized or grounding type.

Added 11.2.1.5.1 effective August 2, 2001

11.2.1.6 If a 3–wire grounding-type or a 2–wire polarized attachment plug is provided, the circuit conductors in the flexible cord shall be connected to the plug and to the wiring in the product so that any of the following devices used in the primary circuit shall be connected in an ungrounded side of the line: the center contact of the Edison-base lampholder, a single pole switch, an automatic control with a marked off position, a single fuseholder, and any other single-pole overcurrent protective device.

Revised 11.2.1.6 effective August 2, 2001

11.2.1.6.1 If a 3–wire grounding-type attachment plug or a 2–wire polarized attachment plug is provided, the attachment plug connection shall comply with Figure 11.1 and the polarity identification of the flexible cord shall comply with Table 11.3.

Added 11.2.1.6.1 effective August 2, 2001

Table 11.3
Polarity identification of flexible cords

Table 11.3 revised August 6, 2004

Method of identification	Acceptable combinations		
	Wire intended to be grounded[d]		All other wires[d]
Color of braids on individual conductors	A	Solid white or gray - without tracer	Solid color other than white or gray - without tracer
	B	Color other than white or gray, with tracer in bold	Solid color other than white or gray - without tracer
Color of insulation on individual conductors	C[a]	Solid white or gray	Solid color other than white or gray
	C1[e]	Light blue	Solid color other than light blue, white, or gray
Color of separators	D[b]	White or gray	Color other than white or gray
Other means	E[c]	Tin or other white metal on all strands of the conductor	No tin or other white metal on the strands of the conductor
	F[b]	A stripe, ridge, or groove on the exterior surface of the cord	

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

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

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

[d] A wire finished to show a green color with or without one or more yellow stripes or tracers is to be used only as an equipment grounding conductor. See 27.5 and Figure 11.1.

[e] For jacketed cord.

11.2.1.7 If a fused polarized attachment plug is provided, the screw shell of the plug fuseholder and accessible contact of an extractor fuseholder shall be connected toward the load.

Revised 11.2.1.7 effective August 2, 2001

11.2.2 Pin terminals

11.2.2.1 If a product is provided with pin terminals, the construction of the product shall be such:

a) That no live parts will be exposed to unintentional contact both during and after the placement of the plug on the pins, in the intended manner and

b) That the pins are not subjected to mechanical damage when the plug is not connected.

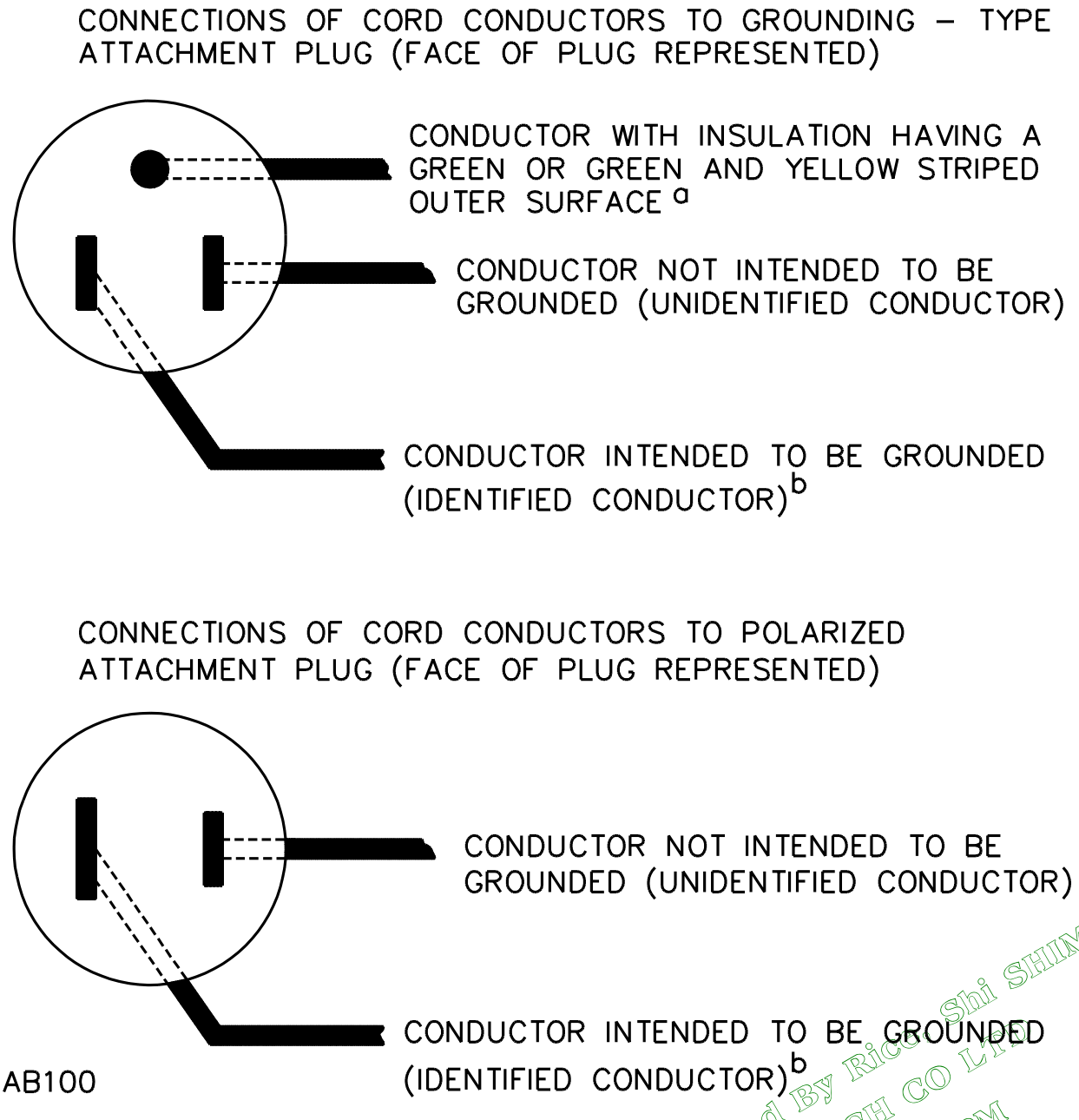
11.2.2.2 A pin guard is required, such that:

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

b) With the plug aligned with the pins and the face of the plug in a plane located perpendicular to the end or ends of the farthest projecting current-carrying pin, the probe illustrated in Figure 8.1 should not touch any current-carrying pin while the probe is inserted through any opening with the product in any position.

Figure 11.1
Connections to attachment plug

Added Figure 11.1 effective August 2, 2001



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

[b] Signifies a conductor identified in accordance with Table 11.3.

11.2.3 Strain relief

11.2.3.1 Strain relief shall be provided so that a stress on a flexible cord, such as a pull or twist, will not be transmitted to a terminal, splice, or internal wiring in the product.

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

11.2.3.3 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be a bushing or the equivalent that is substantial, reliably secured in place, and that has a smooth, rounded surface against which the cord can bear. If Type SP-1, SPE-1, SPT-1, SP-2, SPE-2, SPT-2 or other cord lighter than Type SJ is employed, if the wall or barrier is of metal, and if the construction is such that the cord might be subjected to strain or motion, an insulating bushing shall be provided. The heat and moisture resistant properties of the bushing material shall be acceptable for the particular application.

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

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

11.2.3.6 A separate soft rubber, neoprene, or polyvinyl chloride bushing may be employed in the frame of a motor or in the enclosure of a capacitor physically attached to a motor, but not elsewhere in a product, provided that:

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

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

Exception: A bushing of any of the materials mentioned may be employed at any point in a product if used in conjunction with a type of cord for which an insulating bushing is not required, and if the edges of the hole in which the bushing is mounted are smooth and free from any burr, fin, and the like.

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

12 Live Parts

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

12.2 Plated iron or steel may be used for a current carrying part whose temperature during normal operation is more than 100°C (212°F), within a motor or associated governor, or if in accordance with 3.1; however, unplated iron or steel is not acceptable. Stainless steel and other corrosion resistant alloys may be used for current carrying parts regardless of temperature.

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

12.4 Friction between surfaces is not acceptable as a means to prevent shifting or turning of an uninsulated live part, but a properly applied lockwasher is acceptable for this purpose.

13 Reservoir

13.1 If a reservoir is part of a product, a live part shall be so located or protected that it will not be subject to dripping if the reservoir fails.

Exception No. 1: This requirement does not apply if the reservoir is resistant to corrosion from the liquid intended for use in it and if the reservoir does not develop cracks as a result of aging.

Exception No. 2: The live parts need not be protected from contact with a dripping liquid if the reservoir is resistant to corrosion from the liquid intended for use in it, and the product is subjected to the Reservoir Overflow Test (Section 53) with acceptable results.

14 Dispensers

14.1 Live parts of a product that employs a device for dispensing a liquid, shall be located or otherwise protected so that they will not come in contact with the liquid under any condition of failure of the dispenser or its associated parts (reservoir, washer, plunger, etc.)

Exception: The live parts need not be protected from contact with a liquid if:

a) All parts with which the liquid is in contact during normal use, and which can be contacted as a result of failure of the dispenser – or its associated part – are resistant to chemical reaction from any liquid intended to be used; and

b) A sample of the product is subject to the "Dispenser Leakage Test" (Section 54) with acceptable results.

15 Internal Wiring

15.1 The wiring and connections between parts of a product shall be protected or enclosed.

Exception: A necessary length of flexible cord may be employed for external connections between parts of the product if flexibility is essential.

15.2 Deleted August 4, 1998

15.2.1 Wires within an enclosure, compartment, raceway, or the like shall be located or protected to reduce the likelihood of contact with any sharp edge, burr, fin, moving part or the like that may abrade the insulation on conductors or otherwise damage wires.

15.2.1 added August 4, 1998

15.3 A hole in a sheet metal wall through which insulated wires pass shall be provided with a smooth rounded bushing or shall have a smooth, well rounded surface upon which the wires may bear so that the insulation will not be damaged.

15.4 A separate foot switch provided with a product shall be connected to the product by flexible cord no lighter than Type SJ or an equivalent construction.

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

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

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

c) Exposure to moisture, and

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

15.6 A splice and connection shall be mechanically secure and shall provide a positive electrical contact.

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

15.8 If a wire-binding screw construction, or a pressure wire connector is used as a terminating device for aluminum it shall be acceptable for use with aluminum under the conditions involved – for example, temperature, heat cycling, vibration.

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

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

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

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

15.13 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 provided.

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

16 Separation of Circuits

16.1 An insulated conductor shall not touch any other insulated conductor or uninsulated live part operating at a higher potential unless the conductor is acceptable for use at the higher potential. This includes the conductors in terminal compartments and boxes as well as internal wiring.

16.2 Conductors that operate at different potentials but are not insulated for the highest potential between them as indicated in 16.1 shall be permanently separated from one another by an insulating barrier, routing, or acceptable clamping.

17 Printed Wiring

17.1 Because of risk of electric shock or fire, that could occur due to loosening of the bond between the conductor and the base material, printed-wiring boards used in primary circuits and secondary circuits shall be acceptable for the application, see 8.2 and 8.3.

17.2 Printed-wiring boards used in circuits where loosening of the bond between the conductor and the base material does not result in a risk of fire or electric shock are considered to be acceptable for the application without further investigation.

17.3 The securing of components, such as resistors, capacitors, inductors, transformers, and the like, to a printed-wiring board to form a printed-wiring board assembly, and the mounting of the printed-wiring assembly itself, shall be such that any forces that might be exerted on the components or board during assembly, shipping or handling of the equipment, or during use or servicing, will not displace the components or deflect the board so as to produce a risk of electric shock or fire.

18 Heating Element

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

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

19 Electrical Insulation

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

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

factors are to be considered with respect to thermal aging. For a product in which a polymeric enclosure also serves as an insulating material, or as the direct or indirect support for any live part, the polymeric material shall comply with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluation, UL 746C.

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

19.4 A small molded part, such as a brush cap, shall be so constructed that it will have strength and rigidity to withstand the stresses of intended service.

20 Thermal Insulation

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

20.2 Some types of mineral wool thermal insulation contain conductive impurities in the form of slag that, if in contact with any uninsulated live parts, may involve a risk of fire, electric shock or injury to persons.

20.3 Thermal insulation shall be rated for the temperature to which it is exposed when tested under the conditions described in 47.2.1.1 – 47.2.5.1.

21 Overload Protection

21.1 If overload conditions that could result in a risk of fire or electric shock are likely to occur, the product shall be provided with a circuit breaker, fuse, or inherent electronic circuitry in order to keep such an overload from occurring.

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

21.3 The overcurrent protection mentioned in 21.2 shall be of a type acceptable for branch circuit protection.

22 Overtemperature Protection

22.1 A product shall be provided with a temperature limiting device if malfunction of the temperature regulating control results in a risk of fire or electric shock due to overheating.

23 Receptacles

23.1 For a product provided with a grounding means, any convenience receptacle shall be of the grounding type.

23.2 A product provided with one or more general-use receptacles shall not be equipped with a flexible cord smaller than No. 16 AWG (1.31 mm^2).

24 Switches and Controls

24.1 A switch or other control device shall be acceptable for the application, with a rating per circuit, or in the case of a multiple position device, a rating per position not less than that of the load that it controls.

24.2 With reference to the requirement in 24.1, the current-carrying capacity of a switch that controls an inductive load, such as a transformer or an electric-discharge lamp ballast, is required to not be less than twice the rated full-load current of the transformer or ballast unless the switch is rated for the particular application.

24.3 If a product that is intended for connection to the branch-circuit supply by means of a flexible cord and an attachment plug contains a motor rated at more than 1/3 hp (249 W), an acceptable manually-operated motor-control device shall be provided in the product.

24.4 A switch shall be so located or protected that it will not be subjected to mechanical damage in intended use.

25 Transformers

25.1 A transformer intended to be connected across a supply circuit shall be housed within its own enclosure or within the overall enclosure of the product.

25.2 The insulation between uninsulated, primary wires of opposite polarity shall be one of the following:

a) Electrical grade paper, waxed or otherwise treated to resist the absorption of moisture, having a total thickness of not less than 0.013 inch (0.33 mm).

b) Other insulating material mechanically and thermally equivalent to that of (a) and having a dielectric breakdown strength of not less than 2500 V in the thickness used.

Exception: Insulation need not be provided if the spacings required by 26.2.1 are provided.

25.3 Insulation between the primary and secondary windings shall be one of the following (for additional requirements applicable to flanged bobbin-wound transformers, see 25.4):

a) Electrical grade paper, waxed or otherwise treated to resist the absorption of moisture, having a total thickness of not less than 0.013 inch (0.33 mm).

b) A polymeric coil form having a thickness of not less than 0.025 inch (0.64 mm).

c) Insulation as specified in 25.2(b).

25.4 A flanged, bobbin-wound transformer, having:

a) The primary winding wound over the secondary winding or the secondary winding wound over the primary winding and

b) The primary insulation from the secondary winding by a layer of insulating material, shall comply with the following:

1) The insulation shall have a continuous 1/32-inch (0.8-mm) wide bent-up edge against both bobbin end flanges, and

2) The tests described in 51.2.1 – 51.2.8 shall be continued for 15 days.

25.5 Insulation between the primary winding and the core shall be one of the following:

a) Electrical grade paper, waxed or otherwise treated to resist moisture, having a total thickness of not less than 0.013 inch (0.33 mm).

b) A polymeric coil form having a thickness of not less than 0.025 inch (0.64 mm).

c) Insulation as specified in 25.2(b).

25.6 Insulation between the primary-winding-lead connections and a metallic enclosure (end bells) shall be one of the following:

a) Electrical grade paper, waxed or otherwise treated to resist the absorption of moisture, not less than 0.013 inch (0.33 mm) thick if used in conjunction with an air spacing of one-half that specified in 26.2.1.

b) Electrical grade paper, waxed or otherwise treated to resist the absorption of moisture having a total thickness of not less than 0.028 inch (0.71 mm) when the insulation is in contact with the end bell.

c) Insulation that is thermally and mechanically equivalent to that in (a) or (b) and having a dielectric breakdown strength of 2500 V and 5000 V in the thickness specified in (a) and (b), respectively.

Exception: Insulation need not be provided if the spacings required by 26.2.1 are provided.

25.7 Insulation between a crossover lead and the turns of the winding to which it is connected, the adjacent winding, the metallic enclosure, and the core shall be one of the following:

a) Electrical grade paper, waxed or otherwise treated to resist the absorption of moisture, having a total thickness of not less than 0.013 inch (0.33 mm).

b) Insulation as required by 25.2(b).

Exception No. 1: The spacings required by 26.2.1 may be provided in lieu of insulation.

Exception No. 2: Insulation between a crossover lead and the winding to which it is connected is not specified if:

a) The coil withstands the dielectric voltage-withstand test described in 48.2.1 with the potential applied between the coil leads and with the coil lead cut at the point where it enters the inner layer or

b) The coil withstands the induced-potential test described in 48.5.1 – 48.5.3. See 25.8.

Exception No. 3: This requirement does not apply to insulation between a Class 2 secondary crossover lead and

a) The secondary winding to which the crossover lead is connected,

b) The metallic enclosure, and

c) The core.

25.8 With reference to Exception No. 2 to 25.7, the magnet coil of a molded-bobbin transformer having a slot for the crossover or start lead – unspliced at the windings – need not incorporate a slot fill if the magnet-coil winding withstands the induced-potential test described in 48.5.1 – 48.5.3.

25.9 Insulation between the primary-lead connections and the adjacent winding, and between secondary-lead connections and the primary winding shall be one of the following:

a) Electrical grade paper, waxed or otherwise treated to resist the absorption of moisture, having a total thickness of not less than 0.028 inch (0.71 mm).

b) Other insulating materials mechanically and thermally equivalent to that in (a) and having a dielectric breakdown strength of not less than 5000 V.

25.10 A plug-in transformer unit shall comply with the requirements for plug-in transformer units, UL 1310.

26 Spacings

26.1 Field-wiring terminals

26.1.1 The spacings between field-wiring terminals of opposite polarity and the spacings between a field-wiring terminal and any other uninsulated metal part (dead or live) not of the same polarity shall not be less than indicated in Table 26.1.

Table 26.1
Minimum acceptable spacings in inches (mm) at field-wiring terminals

Potential involved in volts (RMS)	Between wiring terminals through air or over surface[a]	Between terminal and other uninsulated metal parts not always of the same polarity[a]	
		Over surface	Through air
250 or less	1/4 (6.4)	1/4 (6.4)	1/4 (6.4)

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

26.2 Primary circuits

26.2.1 In primary circuits, other than at field-wiring terminals, the spacings between uninsulated live parts of opposite polarity and between an uninsulated live part and any other uninsulated conductive part, (dead metal part or live part) not of the same polarity shall not be less than indicated in Table 26.2, except that internal motor spacings shall comply with spacing requirements in the Standard for Electric Motors, UL 1004. If an insulated live part is not rigidly fixed in position by a means other than friction between surfaces or if a movable part is in proximity to an uninsulated live part, the construction shall maintain at least the minimum acceptable spacings shown regardless of the position of the part.

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

26.2.3 The spacing requirements given in Table 26.2 do not apply to the inherent spacings of a component of the product, such as a snap switch; such spacings are investigated on the basis of the requirements for the component in question.

Table 26.2
Minimum acceptable primary-circuit spacings in inches (mm) at other than field-wiring terminals or inside motors

Potential involved in volts (RMS)	Over surface[b]	Through air
125 or less	1/16 (1.6)	1/16 (1.6)
126—250	3/32[a] (2.4)	3/32[a] (2.4)

[a] In products employing heaters, such as sterilizers, warmers, and the like the spacings may be 1/16 inch (1.6mm) at the heating element.

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

26.2.4 At terminal screws and studs to which connection can be made in the field by means of wire connectors, eyelets, or the like, as indicated in 2.7, it is required that the spacings be not smaller than shown in Table 26.2 while such connectors, eyelets, and the like are in such position that minimum spacings (opposite polarity and to dead metal) exist.

26.2.5 An insulating liner or barrier of vulcanized fiber or similar material employed where a spacing would otherwise be less than the minimum acceptable value shall not be less than 1/32 inch (0.8 mm) thick, and shall be so located or of such material that it will not be adversely affected by arcing.

Exception: Vulcanized fiber not less than 1/64 inch (0.4 mm) thick may be used in conjunction with an air spacing of not less than 50-percent of the minimum acceptable through-air spacing.

26.2.6 Insulating material having a thickness less than that specified in 26.2.5 may be used if, upon investigation, it is found to be acceptable for the particular application.

26.2.7 The barriers shall be reliably held in place by means more secure than friction between surfaces. The elasticity of tubing shall not be depended upon to hold the tubing in place, but dilated or heat-shrunk tubing is acceptable.

26.2.8 Unless protected from mechanical abuse during any user assembly or servicing and intended functioning of a product, a barrier of mica shall be 0.010 inch (0.25 mm) or more thick.

26.3 Secondary circuits

26.3.1 Primary-circuit spacings apply in all secondary circuits supplied by a transformer winding of a 200-VA or higher capacity (maximum available power) at a potential higher than 100 V. The spacings in all other secondary circuits are to be investigated on the basis of the dielectric voltage-withstand test in 48.3.1.

27 Grounding

27.1 All permanently connected products shall have provision for grounding all exposed dead metal parts that might become energized.

27.2 A double-insulated product shall not be provided with a means for grounding.

27.3 If a grounding means is provided on the product, whether required or not, all exposed dead metal parts and all dead metal parts within the enclosure that are exposed to contact during any servicing operation and that are likely to become energized shall be reliably connected to the grounding means, see Grounding Impedance Test, Section 50.

27.4 The following are considered to constitute means for grounding:

a) In a product intended to be permanently connected – an equipment-grounding terminal or lead,

b) In a cord-connected product – an equipment-grounding conductor in the cord.

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

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

b) Conductively connected to

1) All exposed dead-metal parts that are likely to become energized and

2) All dead-metal parts within the enclosure that are exposed to contact during any user servicing and that are likely to become energized. The grounding conductor shall be connected by means of a screw or other means not likely to be removed during any servicing operation not involving the power supply cord. Solder alone shall not be used for securing this conductor; and

c) Connected to the fixed grounding member of an attachment plug of the grounding type.

28 Brushes and Brush Holders

28.1 A brush cap shall be recessed, enclosed, or otherwise protected from mechanical damage that might occur during use of the product.

28.2 A brush cap that is accessible to the user without the removal of a guard or enclosure shall be provided with a positive means so that it will not disengage from the brush-holder assembly. Screw threads only on the brush cap are not considered a positive means.

28.3 A brush-holder assembly shall be constructed so that when a brush is worn out – no longer capable of performing its function – the brush, spring, and other parts of the assembly will be retained to the degree necessary to reduce the likelihood of accessible dead-metal parts becoming energized and live parts becoming accessible.

29 Double Insulation

29.1 A product constructed with double insulation and marked as such shall comply with the requirements for double insulation systems for use in electrical equipment, UL 1097, in addition to requirements contained here. Where requirements supersede requirements in the standard, the more severe would apply.

PROTECTION AGAINST INJURY TO PERSONS

30 General

30.1 If the operation and maintenance of a product by the user involves the risk of injury to persons, protection shall be provided to reduce the risk.

30.2 When investigating a product with respect to the requirement in 30.1, consideration shall be given to reasonably foreseeable misuse of the product.

30.3 The adequacy of a guard, a release, an interlock, and the like, and whether such a device is required, are to be determined from an investigation of the complete product, its operating characteristics, and the likelihood of a risk of injury to persons resulting from a cause other than gross negligence. The investigation is to include consideration 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 the breakdown or malfunction of a particular component can result in a risk of injury to persons, that component is to be investigated for reliability.

30.4 Specific constructions, tests, markings, guards, and the like are detailed for some common constructions. Specific features and products not covered herein are to be given appropriate consideration. See the requirements for marking in Details, Section 62.

31 Sharp Edges

31.1 Each edge, projection, and corner of an enclosure, opening, frame, guard, knob, handle, or the like of a product shall be smooth and shall not cause injury to persons during intended use or during operator maintenance of the product.

31.2 For edges whose acceptability cannot be determined by inspection, compliance with the requirements in 31.1 is to be investigated by the test procedure in the requirements for determination of sharpness of edges in electrical equipment, UL 1439.

32 Enclosures and Guards

32.1 A moving part that may cause risk of injury to persons shall be enclosed, guarded, located, or otherwise arranged to reduce the likelihood of unintentional contact.

Exception: A part or portion of a part that is necessarily exposed to perform the work function need not be enclosed but, when necessary, guarding shall be provided. See 32.3.

32.2 A moving part that may involve a risk of injury to persons shall be located or enclosed to reduce the risk of unintentional contact by persons. Such a part shall be considered with respect to

a) The degree of exposure necessary to perform the intended function,

b) The sharpness of the moving part,

c) The likelihood of unintentional contact therewith,

d) The speed of the moving part, and

e) The likelihood that a part of the body or clothing would be endangered by the moving part.

These factors are to be considered with respect to both intended operation of the product and reasonably foreseeable misuse.

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

a) Removability without the use of tools;

b) Removability for servicing;

c) Strength and rigidity;

d) Completeness;

e) Creation of additional risk of injury to persons such as pinch points, and the necessity for additional handling because of the increased need for servicing, such as for cleaning, unjamming, and the like.

32.4 An enclosure or guard over a rotating part shall retain a part that, because of breakage or other reasons, may become loose or may separate from a rotating part, and retain a foreign object that may be struck and propelled by the rotating part.

33 Materials

33.1 The material of a part – such as an enclosure, a frame, a guard, or the like – the breakage or deterioration of which might result in a risk of injury to persons shall have such properties as to meet the demand of expected loading conditions.

33.2 The requirement in 33.1 applies to those portions of a part adjusted to a moving part considered to involve a risk of injury to persons.

34 Surface Temperatures

34.1 During the normal temperature test described in Temperature Test, Section 47, the temperature of a surface that may be contacted by the user shall not be more than the maximum acceptable value specified in Table 34.1.

Table 34.1
Surface temperatures

Location	Composition of surface[a]	
	Metallic	Nonmetallic
A handle or knob that is grasped for lifting, carrying or holding	50°C (122°F)	60°C ((140°F)
A handle or knob that is contacted but does not involve lifting, carrying, or holding and other surfaces subject to contact in operation and user maintenance	60°C (140°F)	85°C (185°F)
A surface subject to casual contact	70° (158°F)	95°C (203°F)

[a] A handle, knob or the like made of a material other than metal, that is plated or clad with metal having a thickness of 0.005 inch (0.13 mm) or less is evaluated as a nonmetallic part.

34.2 All values for temperatures specified in Table 34.1 are based on a 25°C (77°F) ambient temperature; however, tests may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F) and corrected to 25°C (77°F). See 47.1.3 – 47.1.8.

35 Stability

35.1 Overturning of a portable or free-standing product, one not secured in place, when it is tested as described in 35.2 and 35.3, shall not result in a risk of injury to persons.

Exception: A product that is completely hand supported in use need not be tested.

35.2 The product is not to be energized during the stability test. The test is to be conducted under conditions most likely to cause the product to overturn. The following conditions are to be such as to result in the least stability:

a) The position of all doors, drawers, casters, and other movable or adjustable parts, including that of the supply cord resting on the surface supporting the product;

b) Connection or omission of any attachment made available or recommended by the manufacturer;

c) Provision or omission of any intended load if the product is intended to contain a liquid or other mechanical load; and

d) Direction in which the product is tipped or the supporting surface is inclined. See 35.3.

35.3 In conducting the stability test, the product 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.

36 Strength of Handles

36.1 A handle used to completely support or carry a product during use shall withstand a force of four times the weight of the product without damage – to the handle, its securing means, or that portion of the enclosure to which the handle is attached – that will affect the performance of the handle or the product.

36.2 To determine whether a product complies with the requirements in 36.1, the weight of the product plus a force of three times its weight are to be used. The load is to be uniformly applied over a 3 inch (76.2 mm) width at the center of the handle without clamping. The load is to be started at zero and gradually increased so that the test value will be reached in 5 to 10 seconds and is to be maintained for 1 minute. If more than one handle is furnished on a product, and the product cannot be carried by one handle, the force is to be distributed between the handles. The distribution of force is to be determined by measuring the percentage of the product weight sustained by each handle with the product in the normal carrying position. If a product is furnished with more than one handle and can be carried by only one handle, each handle is to sustain the total force.

37 Rotating or Moving Members

37.1 A rotating member, the breakage of which might create a risk of injury to persons, shall be constructed so as to reduce the likelihood of its breakage, or the release or loosening of a part that could become a risk of injury to persons.

37.2 To determine whether a product employing a series motor complies with the requirement in 37.1, it is to be tested as described in 37.3. A part that can become a risk of injury to persons shall not work loose as a result of the test.

37.3 For the test referenced in 37.2, a product employing a series motor is to be operated for 1 minute at the no-load speed resulting from application of 1.3 times rated voltage.

37.4 A product with a user-removable rotating part, secured by threaded hardware - such as a nut - shall be constructed so that the direction of rotation tends to tighten the nut that secures the rotating part in place.

37.5 Unless secured as described in 37.4, a removable rotating part not intended to be removed by the user, shall be secured by a keyed nut, a jam nut, a nut locked in place with a pin, or other equivalent means.

38 Parts Subject to Pressure

38.1 A part of a product that is subjected to air or vapor pressure during normal or anticipated abnormal operation shall withstand, without rupture, a pressure corresponding to five times:

a) The relief-valve pressure setting provided in the system,

b) The maximum pressure that can be developed in the system – but not greater than the relief valve setting, or

c) The marked maximum pressure to which the system may be exposed by an external pressure source.

Exception: A section of a pressure system constructed of continuous tubing or of lengths of tubing connected by conventional tubing fittings or hard-soldered, brazed, or welded joints if study and analysis indicate that the strength of the part is adequate for the purpose.

38.2 If a test is necessary to determine whether a part complies with the requirement in 38.1, two samples of the part are to be subjected to the hydrostatic strength test and withstand without rupture for one minute a hydrostatic pressure per 38.1. The results are not acceptable if either sample bursts.

38.3 With reference to the requirements in 38.2 the test is to be conducted by filling the part with water so as to exclude all air, connecting the pressure vessel to a hydraulic pump, gradually increasing the pressure to the specified test value, and holding it at that value for 1 minute.

39 Pressure-Relief Devices

39.1 A means for relieving pressure shall be provided for a part in which pressure might be generated by an external source of heat.

39.2 A means for relieving pressure – a pressure-relief device, a fusible plug, a soldered joint, nonmetallic tubing, or other equivalent means – shall be employed to comply with the requirement in 39.1.

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

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

39.5 A vessel having an inside diameter of more than 3 inches (76 mm) and subject to air or stream pressure generated or stored within the product shall be protected by a pressure-relief device.

39.6 The start-to-discharge pressure setting of a pressure-relief device shall not be higher than the marked working pressure. The discharge rate of the device shall be adequate to relieve the pressure.

39.7 A pressure-relief device shall:

a) Be connected as close as possible to the part of the product that it is intended to protect;

b) Be installed so that it is readily accessible for inspection and repair, and cannot be readily rendered inoperative so that it will not perform its intended function; and

c) Have its discharge opening located and directed so that:

1) Operation of the device will not deposit moisture on bare live parts or on insulation or components detrimentally affected by moisture, and

2) The likelihood of scalding persons is reduced.

39.8 A pressure-relief device having an adjustable setting is determined on the basis of the maximum setting unless the adjusting means is reliably sealed at a lower setting.

39.9 If a pressure-relief device is required in accordance with 39.5, a control depended upon to limit the pressure in a vessel shall:

a) Comply with the applicable requirements in the Standard for Limit Controls, UL 353, or the applicable requirements for refrigeration limiting devices in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873, and shall have a maximum pressure setting of not more than 90 percent of the rating of the pressure-relief device, or

b) Operate so that the pressure-relief device described in 39.7 does not operate during or after the test described in 39.10.

39.10 A pressure-limiting control shall perform under rated load for 30,000 cycles of operation with no shift in calibration greater than 5 percent above the initial calibration pressure setting. An adjustable control is to be tested at its highest pressure setting unless the adjusting means is reliably sealed at a lower setting.

40 Switches, Controls, and Interlocks

40.1 A product shall be constructed so that unexpected operation will not occur that may cause injury to persons, such as from moving parts, hot liquids, and the like.

40.2 If unintentional operation of a switch can result in a risk of injury to persons, the actuator of the switch shall be located or guarded so that such operation is unlikely.

40.3 The actuator of a switch may be guarded by recessing, ribs, barriers, or the like.

40.4 A device that automatically starts a product, such as a pressure control, timer, an automatically reset overload-protective device, or the like, shall not be employed unless it can be demonstrated that automatic starting will not present a risk of injury to persons.

40.5 The requirement in 40.4 will necessitate the use of an interlock if moving parts or the like could result in a risk of injury to persons upon the automatic starting or restarting of the motor.

40.6 The actuator of an interlock switch shall be located so that unintentional operation is unlikely. See 40.3.

40.7 Operation of an interlock during use shall not inconvenience the operator so as to encourage deliberate defeat of the interlock.

40.8 An interlock shall not be likely to be defeated by materials that could accumulate during use of the product.

40.9 An interlock shall be such that it can be defeated readily only by:

a) Damaging the product,

b) Making wiring connections or alterations, or

c) Using materials that are not readily available.

40.10 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 permits operation of the parts being guarded. With the guard removed, the interlock shall comply with the requirement in 40.6.

40.11 A product that is provided with a maintained contact switch or a switch that can be locked on shall not create a risk of injury to persons when the product is in an at rest position and connected to the source of supply with the switch on.

40.12 For a product that is partially or completely hand-supported, the requirement in 40.11 will necessitate a means to keep the product from traveling more than 6 inches (152 mm) in any one direction in 15 seconds when the product is placed on a hardwood surface while energized.

40.13 The off position of a switch other than a momentary-contact switch shall be such that the operator can determine by visual inspection that the product is off.

PERFORMANCE

41 General

41.1 The sample used for the Temperature Test, Section 47, shall be employed in the dielectric-withstand test, see 48.2.1 – 48.3.4.

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

a) For a product rated from 110 V to 120 V, inclusive, 120 V;

b) For a product rated from 220 V to 240 V, inclusive, 240 V; and

c) For a product other than as mentioned in (a) or (b), the maximum rated voltage of the product.

41.3 A product having a single frequency rating is to be tested at that frequency. A product rated ac/dc or dc-60 Hz is to be tested on direct current or 60-Hz alternating current, whichever results in the most severe condition. A product rated 25 – 60 Hz or 50 – 60 Hz is to be tested on 60-Hz alternating current.

41.4 Wherever cloth is mentioned in the abnormal tests, the cloth is to be bleached cheesecloth, running 14 – 15 yd^2/lb (approximately 26 – 28 m^2/kg) and having what is known in the trade as a ″count of 32 by 28,″ that is, for any square inch 32 threads in one direction and 28 threads in the other direction — or any square centimeter, 13 threads in one direction and 11 in the other direction.

42 Operational Test

42.1 Operation of a product as described in 42.2 shall not increase the risk of fire, electric shock, or injury to persons.

42.2 With reference to 42.1, an as-received sample of the product is to be set up or installed in accordance with the manufacturer's instructions. The sample is to be operated in — accordance with the manufacturer's instructions with respect to – the intended uses of the product, including maintenance and cleaning recommended by the manufacturer and lack of such maintenance and cleaning; and with all accessories recommended by the manufacturer for use with the product. The product is to be manipulated as it would be in actual use, including manipulation of all controls and operation under the various loading conditions that can be expected. The product is to be operated for a sufficient length of time or through a sufficient number of cycles so that all reasonably foreseeable complications are revealed.

43 Leakage Current Test

43.1 The leakage current of a cord- and plug-connected product when tested in accordance with 43.3 – 43.7 shall be no more than 0.5 mA.

Exception No. 1: For a grounded (3-wire) product, fastened in place, the leakage current shall not be more than 0.75 mA.

Exception No. 2: For a grounded (3-wire) product, intended for use in a dedicated location, see 11.1.1.3, the leakage current shall not be more than 0.75 mA.

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

43.3 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure considered as protection against electric shock as defined in Frame and Enclosure, Section 8. Surfaces are considered to be simultaneously accessible when they can be readily contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages considered not to present a risk of electric shock.

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

43.5 The measurement circuit for leakage current is to be as shown in Figure 43.1. The measurement instrument is defined in (a) – (d). The meter actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used need not have all the attributes of the defined instrument.

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

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

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

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

43.6 A sample of the product is to be tested for leakage current starting with the ″as received″ condition, but with its grounding conductor, if any, open at the attachment plug (open at receptacle as shown in Figure 43.1). The ″as received″ condition is without prior energization, other than that which may have occurred as part of the production line testing. The supply voltage is to be adjusted to 120 or 240 V depending on the rating. Thermostats are to be closed. The test sequence, with reference to the measuring circuit (Figure 43.1) is to be as follows:

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

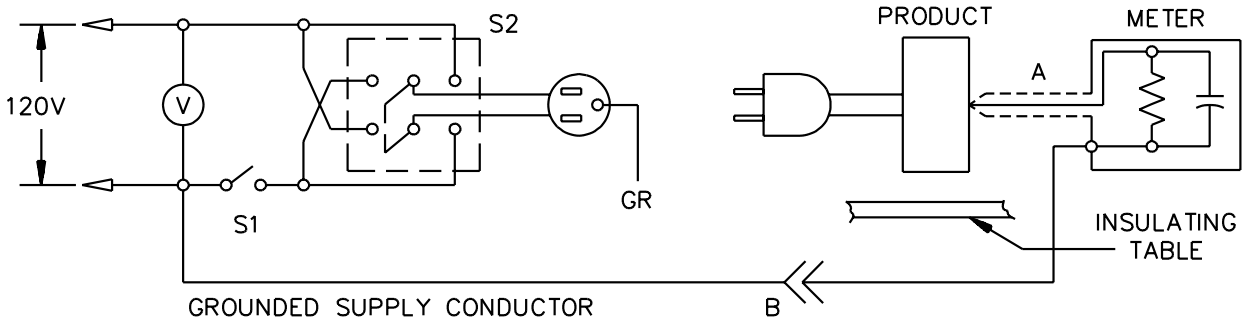
b) Switch S1 is then to be closed, energizing the product, and within a period of 5 seconds, the leakage current is to be measured using both positions of switch S2, and with the product operated at the maximum heat setting of controls.

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

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

Figure 43.1
Leakage current measurement circuits

Figure 43.1 revised August 4, 1998



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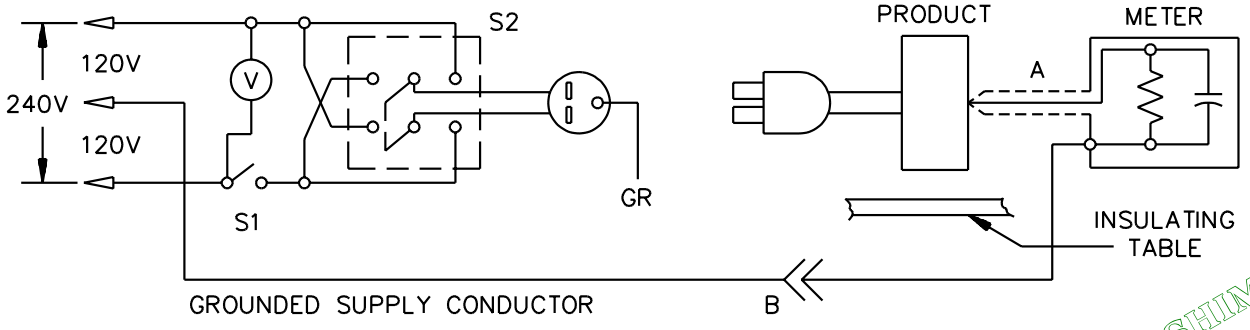

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NOTES –

A – Probe with shielded lead.

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

43.7 Usually, a sample will be carried through the complete leakage current test program as covered by 43.6, without interruption for other tests. With the concurrence of those concerned, the leakage current tests may be interrupted for the purpose of conducting other nondestructive tests.

44 Leakage Current Following Humidity Conditioning Test

44.1 A product shall comply with the requirements for Leakage Current Test, Section 43, following exposure for 48 hours to moist air having a relative humidity of 88 ±2 percent at a temperature of 32.0 ±2.0°C (89.6 ±3.6°F). The product is to be tested as follows:

a) The product is to be at a temperature just above the test chamber temperature when it is placed in a humidity chamber.

b) The product is to remain in the humidity chamber for 48 hours.

c) Following this exposure, while still in the test chamber, the sample is to be tested unenergized as indicated in 43.6(a).

d) The sample is then to be tested energized as indicated in 43.6 (b) and (c), until the leakage current has stabilized or decreased.

45 Starting Current Test

45.1 A motor-operated product shall start and operate normally on a circuit protected by an ordinary – not time-delay – fuse having a current rating corresponding to that of the branch circuit to which the product should be connected. The performance is unacceptable if the fuse opens or an overload protector provided as part of the product trips.

45.2 In a test to determine whether a product complies with the requirement in 45.1, the product is to be started three times, with the product at room temperature at the beginning of the test. Each start of the motor is to be made under conditions representing the beginning of normal operation – the beginning of the normal operating cycle, in the case of an automatic product – and the motor is to be allowed to come to rest between successive starts.

45.3 In addition to complying with the requirements of 24.1, a switch or other device that controls a solenoid, relay coil, or the like and has not been tested and shown to be acceptable for this purpose shall perform acceptably when subjected to an overload test consisting of 50 cycles of operation as described in 45.4. The switch shall be electrically and mechanically operable at the conclusion of the test; at which time, the switch shall be capable of performing its intended function and shall show no wear, loosening of parts, or defects of any other description that will appreciably diminish the usefulness and reliability of the switch.

45.4 In a test to determine whether a switch or other control device complies with the requirements in 45.3, the product is to be connected to a grounded supply circuit of rated frequency and 110-percent of maximum rated voltage. The load on the device under test is to be the same as that which it is intended to control in intended service. During the test, exposed metal parts of the product are to be connected to ground through a 3 A fuse, and the connection is to be such that any single-pole, current-rupturing device will be located in the ungrounded conductor of the supply circuit. If the product is intended for use on direct current, or on direct current as well as alternating current, the exposed dead metal parts of the product are to be connected to be positive with respect to a single-pole, current-rupturing, control device. The device is to be operated at a rate of not more than ten cycles per minute, except that a faster rate of operation may be employed if agreeable to all concerned. The performance is unacceptable if the fuse in the grounding connection is opened during the test.

45.5 In addition to complying with the requirements of 24.1, a switch or other device that controls a motor of a product – unless tested and shown to be acceptable for this application or unless so interlocked that it will not have to break the locked-rotor motor current – shall be capable of performing

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acceptably when subjected to an overload test consisting of 50 cycles of operation, making and breaking the locked-rotor current of the motor. The switch shall be electrically and mechanically operable at the conclusion of the test; at which time the switch shall be capable of performing its intended function and shall show no wear, loosening of parts, or defects of any other description that will appreciably diminish the usefulness and reliability of the switch.

45.6 In a test to determine whether the switch or other control device is capable of performing acceptably in the overload test mentioned in 45.5, the product is to be connected to a grounded supply circuit of rated frequency and maximum rated voltage (see 41.2) with the rotor of the motor locked in position. During the test, exposed dead metal parts of the product are to be connected to ground through a 3-A fuse, and the connection is to be such that any single-pole, current-rupturing device will be located in the ungrounded conductor of the supply circuit. If the product is intended for use on direct current, or on direct current as well as alternating current, the exposed dead metal parts of the product are to be so connected as to be positive with respect to a single-pole, current-rupturing, control device. The device is to be operated at a rate of not more than 10 cycles per minute, except that a faster rate of operation may be employed if agreeable to all concerned. The performance is unacceptable if the fuse in the grounding connection is opened during the test.

46 Input Test

46.1 The current or wattage input to a product shall not be more than 110 percent of the rated value when the product is operated under the condition of maximum normal load as described in 47.2.1.1 – 47.2.5.1 and when connected to a supply circuit as described in 41.2.

47 Temperature Test

47.1 General

47.1.1 A product, when operated under the conditions of maximum normal load as described in 47.2.1.1 – 47.2.5.1, and while connected to a supply circuit as described in 41.2, shall not attain a temperature at any point sufficiently high to constitute a risk of fire or to affect injuriously any materials employed in the product, nor shall the product show greater temperatures than specified in Table 47.1.

47.1.2 A thermal- or overload-protective device shall not open the circuit during the temperature test.

Exception: A combination temperature-regulating and -limiting thermostat may operate during the temperature test. See 56.3.2(c).

47.1.3 The temperatures specified in Table 47.1 are based on an assumed ambient temperature of 25°C (77°F). A test may be conducted at an ambient temperature within the range of 10 – 40°C (50 – 104°F).

47.1.4 During a test conducted at an ambient temperature of 25°C (77°F), an observed temperature shall not exceed the values specified in Table 47.1.

47.1.5 If a test is conducted at an ambient temperature other than 25°C (77°F), an observed temperature other than as mentioned in 47.1.6 shall be corrected as described in 47.1.7. Neither a corrected temperature nor an observed temperature as mentioned in 47.1.6 shall exceed the values specified in Table 47.1.

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

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

47.1.8 If a corrected temperature exceeds the values specified in Table 47.1, at the request of the manufacturer, the test may be repeated at an ambient temperature closer to 25°C (77°F).

47.1.9 A short length of rubber- or thermoplastic-insulated flexible cord exposed to a temperature of more than 60°C (140°F), such as at terminals, is acceptable if supplementary heat-resistant insulation of comparable dielectric strength is employed on the individual conductors of the cord.

47.1.10 In conducting a test to determine whether a product complies with the temperature requirements, the product is to be mounted or supported as in service, including recessed wall mounting if required. Installation against the wall, in a right angle corner of a room, or in an alcove is to be simulated if the product lends itself to such placement and if such placement results in restricted ventilation. Walls are to be formed by black painted vertical sheets of plywood not less than 3/8 inch (9.53 mm) thick and having such width and height that they extend not less than 2 ft (0.61 m) beyond the physical limits of the product.

47.1.11 Rubber and other material subject to deterioration is to be removed from feet and other supports of the product if absence of the material might result in the product or the supporting surface attaining higher temperatures.

47.1.12 An automatic temperature-regulating or -limiting control or other protective device provided as a part of a product is to be shunted out of the circuit, unless the results of an investigation, which would include overload and endurance tests, show the control to be rugged, reliable, and unlikely to be defeated by the user. See Thermostats Test, Section 56.

47.1.13 With reference to those tests that are to be continued until constant temperatures are attained, thermal equilibrium is considered to exist when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5-minute intervals, indicate no change.

Table 47.1
Maximum temperature

Material and components		°C	°F
A.	MOTORS		
	1. Class A insulation systems on coil windings of an a-c motor, not including a universal motor and on vibrator coil[a]		
	(a) In an open motor and on a vibrator coil:		
	Thermocouple or resistance method	100	212
	(b) In a totally enclosed motor:		
	Thermocouple or resistance method	105	221
	2. Class A insulation systems on coil windings of a d-c motor and of a universal motor[a]		
	(a) In an open motor:		
	Thermocouple method	90	194
	Resistance method	100	212
	(b) In a totally enclosed motor:		
	Thermocouple method	95	203
	Resistance method	105	221
	3. Class B insulation systems on coil windings of an a-c motor, not including a universal motor[a]		
	(a) In an open motor:		
	Thermocouple or resistance method	120	248
	(b) In a totally enclosed motor:		
	Thermocouple or resistance method	125	257
	4. Class B insulation systems on coil windings of a d-c motor, and of a universal motor[a]		
	(a) In an open motor:		
	Thermocouple method	110	230
	Resistance method	120	248
	(b) In a totally enclosed motor:		
	Thermocouple method	115	239
	Resistance method	125	257
B.	COMPONENTS		
	1. Capacitors:		
	(a) Electrolytic[c]	65	149
	(b) Other types[d]	90	194
	2. Fuses[e]	90	194

Table 47.1 Continued on Next Page

Table 47.1 Continued

Material and components		°C	°F
	3. Relay, solenoid, and coils (except motor coil windings and transformers) with		
	(a) Class 105 insulation systems		
	Thermocouple method	90	194
	Resistance method	110	230
	(b) Class 130 insulation systems		
	Thermocouple method	110	230
	Resistance method	130	266
	4. Sealing Compound	b	b
	5. Transformers		
	(a) Class 105 insulation systems:		
	Thermocouple method	90	194
	Resistance method	100	212
	(b) Class 130 insulation systems:		
	Thermocouple method	110	230
	Resistance method	120	248
C.	CONDUCTORS		
	1. Rubber- or thermoplastic-insulated wires and cords[e,f]	60	140
D.	ELECTRICAL INSULATION – GENERAL		
	1. Fiber employed as electrical insulation	90	194
	2. Phenolic composition employed as electrical insulation or as a part the deterioration of which could result in a risk of fire or electric shock[e]		
	(a) Laminated	125	257
	(b) Molded	150	302
	3. Varnished-cloth insulation	85	185
E.	SURFACES		
	1. A surface upon which a product may be placed or mounted in service, and a surface that may be adjacent to the product when it is so placed or mounted[g]	90	194
	2. Any point within a terminal box or wiring compartment of a permanently connected product in which power-supply conductors are to be connected, including such conductors themselves, unless the product is marked in accordance with 62.2.1	60	140
	3. Wood or other combustible material, including the inside surface of the test enclosure and the surface supporting the product	90	194
	4. A surface intended for body contact for periods up to 1 hour such as a heated toilet seat	41	106

Table 47.1 Continued on Next Page

Table 47.1 Continued

Material and components	°C	°F
[a] At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature measured by means of a thermocouple may be more than the maximum acceptable temperature specified in this table provided the temperature, as measured by the resistance method, is not more than that specified. The temperature measured by means of thermocouple may be more than the specified value by: 1. 5°C (9°F) for Class A insulation systems on coil windings of alternating-current motors, open type, 2. 10°C (18°F) for Class B insulation systems on coil windings of alternating-current motors, open type, [b] Unless a thermosetting material, the maximum sealing compound temperature, when corrected to a 25°C (77°F) ambient temperature is 15°C (27°F) less than the softening point of the compound as determined by the Ball and Ring Apparatus, ASTM E28-67. [c] For an electrolytic capacitor that is physically integral with or attached to a motor, the maximum acceptable temperature on insulating material integral with the capacitor enclosure may be not more than 90°C (194°F). [d] A capacitor that operates at a temperature of more than 90°C (194°F) may be investigated on the basis of its marked temperature limit. [e] A component or material that has been investigated, and found acceptable for use at a higher temperature, may be used at the temperature. [f] A rubber-insulated conductor within a motor, a rubber-insulated motor lead, and a rubber-insulated conductor of a flexible cord entering a motor may be subjected to a higher temperature if the conductor is provided with sleeving or a braid that has been investigated and found acceptable for use at the higher temperature. This does not apply to thermoplastic-insulated wires or cords. [g] For surfaces that may be contacted by the user, see Surface Temperatures, Section 34.		

47.1.14 Coil winding temperatures are to be measured by thermocouples or by using the change-of-resistance method, whichever is appropriate. For a thermocouple measured temperature of a coil of an alternating-current motor other than a universal motor the thermocouple is to be mounted on the integrally applied insulation on the conductor. For any other motor, the thermocouple may be applied on the outer surface of a wrap that is not more than 1/32 inch (0.8 mm) thick and consists of cotton, paper, rayon, or the like.

47.1.15 Thermocouples are to consist of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). Whenever referee temperature measurements by thermocouples are necessary, thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer-type instrument are to be used. A temperature is determined to be constant when three successive readings, taken at intervals of 10 percent of the previously elapsed test duration, but not less than 5–minute intervals, show no change. The thermocouple wire is to conform with the requirements specified in the Initial Calibration Tolerances for Thermocouples table in Temperature Measurement Thermocouples, ANSI/ISA MC96.1.

47.1.15 revised August 6, 2004

47.1.16 When using the resistance method, the windings are to be at room temperature at the start of the test, and the temperature of a winding is to be calculated using the formula:

$$T = \frac{R(k + t_1)}{r} - k$$

in which:

T is the final temperature in °C,

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

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

t_1 is the temperature in °C of the coil at the time resistance r is being measured,

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.

47.1.16 revised August 2, 2000

47.2 Maximum normal load

47.2.1 General

47.2.1.1 In tests on a product, maximum normal load is considered to be that load which approximates as closely as possible the most severe conditions of normal use. It is not a deliberate overload except as the conditions of actual use are likely to be somewhat more severe than the maximum load conditions that are recommended by the manufacturer of the product. Usually a program designed to test all functions of the product suffices. The normal load includes the maximum marked ampere loading of any receptacles and accessory products. When not marked as mentioned in 62.1.5, the receptacle rating is to be used.

47.2.1.2 Test loads which have been found to be close approximations of the most severe conditions of normal use are indicated in 47.2.2.1 – 47.2.5.1 for some common forms of products. Products not mentioned having features not contemplated, are to be tested as necessary to meet the intent of these requirements with consideration given to the probable intermittent or short-time operation of products obviously not intended for continuous operation.

47.2.1.3 Products with forced air fan cooling shall have all filters covered with a thin layer of loose cotton, simulating an accumulation of dust on the filter.

47.2.2 Denture cleaners

47.2.2.1 The product is to be operated through four operation cycles, each of 15 minutes duration, with a 5 minute off period between successive operations.

47.2.3. Oral irrigation appliances

47.2.3.1 The product is to be operated through four cycles, emptying the reservoir each time at a reasonably strong pressure setting to result in a 4 minute operating on period, with a 5 minute off period between successive operations. A lesser on time may be employed if the reservoir empties during this time at the lowest pressure setting of the product. Tepid water, approximately 37°C (100°F) is to be employed for this test.

47.2.4 Charger units for battery-operated toothbrushes

47.2.4.1 The temperature test is to be conducted with the output of the charger unit short-circuited and operation continued until constant temperatures have been attained.

47.2.5 Toothbrushes

47.2.5.1 A cord-connected product is to be operated through six operational cycles, each of 3 minutes duration, with a 1 minute off period between successive operations.

48 Dielectric Voltage-Withstand Test

48.1 General

48.1.1 The insulation and spacings of a product shall be capable of withstanding for a period of 1 minute the application of the test potentials described in 48.2.1– 48.3.1, 48.4.1, and 48.5.1 – 48.5.3 for 1 minute without an indication of unacceptable performance. For a definition of unacceptable performance see 48.1.3.

Exception: The requirement is not applicable where an investigation shows that unacceptable performance will not result in a risk of fire or electric shock.

48.1.2 Where a separate source is employed to supply the required test potential, the source is to have the capacity to maintain the potential indicated, except in case of unacceptable performance. The voltage source is to be increased and, starting at zero, the test potential is to be increased gradually at a substantially uniform rate so as to arrive at the specified test potential in approximately 5 seconds or until unacceptable performance is indicated.

48.1.3 Unacceptable performance will usually be indicated by the tripping of an appropriate overload protector in the test equipment but an abrupt decrease or retarded nonlinear advance of the voltmeter reading or an abrupt increase in current could also be indicative of insulation breakdown. Particular attention shall be paid to high impedance circuits in the product so that breakdowns resulting in risk of fire or electric shock conditions are detected.

48.1.4 The sensitivity of the test equipment shall be such that when a 120,000 ohm resistor is connected across the output, the equipment does not indicate unacceptable performance for any output voltage less than the specified test voltage, and indicates unacceptable performance for any output voltage equal to or greater than the specified test voltage. The calibrating resistor is to be adjusted as close to 120,000 ohms as instrumentation accuracy can provide, but not more than 120,000 ohms.

Exception No. 1: The sensitivity of the test equipment may be reduced (a lower value of calibrating resistance used) if the circuits or components under test do not involve accessible conductive parts.

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

48.1.4 revised August 6, 2004

48.2 Primary circuits

48.2.1 A 60-Hz essentially sinusoidal potential is to be applied between live parts conductively connected to the supply circuit and dead metal parts and across each capacitor, winding separation, or other insulation in the primary circuit that is required for the reduction of the risk of electric shock or, if short-circuited, would involve a risk of fire either directly or indirectly. The test potential is to be:

a) 1000 V plus twice the maximum rated voltage for a product.

b) 2500 V for a product that involves wet or moist contact directly with persons either during the operation or preparing it for operation – includes electric toothbrushes, lens disinfectors, and the like.

48.2.2 If an isolating type of power transformer is employed, wherein the primary and secondary windings are not conductively connected, a 60-Hz essentially sinusoidal potential is to be applied between any live part of the primary or power-supply circuit and any live part of the secondary circuits. The test potential shall be as indicated in 48.2.1.

48.2.3 A power transformer is to be capable of operating without unacceptable performance when potential is applied to the primary of the transformer to produce three times the open circuit secondary voltage or when tested separately using an appropriate supply on the primary to develop a secondary voltage comparable to that which would have existed had the transformer been tested with the balance of the circuit.

48.3 Secondary circuits

48.3.1 The test potential indicated in Table 48.1 is to be applied between:

a) Secondary circuits and grounded metal, with grounded secondary windings of transformers disconnected, and

b) Between secondary circuit parts of opposite polarity.

A 60-Hz essentially sinusoidal source is to be used for testing alternating-current circuits. A direct-current source may be used for testing a direct-current circuit but, if possible, the transformer in the product should be employed to supply the alternating current to the rectifier – or substitute high-voltage rectifier, if necessary – for the opposite polarity test on direct-current circuits.

Table 48.1
Test potential for secondary circuits

Maximum voltage in the circuit, V	Test potential, V
Less than 50	500
50 – 90	Ten times maximum voltage in circuit
91 – 333	1000
333 – 1000	Three times maximum voltage in circuit
More than 1000	1750 plus 1.25 times the maximum voltage in the circuit

No Text on This Page

48.3.2 All lamps and tubes are to be removed, and ballast tubes or other automatic regulating devices are to be rendered inoperative, if necessary, to carry out the test. All selector or other operating switches are to be adjusted to the various operating positions that enable the connection of these parts in the circuit under test. Bleeder resistors, electrolytic capacitors, transistors, and other power consuming devices are to be opened at the common return side of the circuit.

48.3.3 If the product transformer is included in this test, as per 48.2.3, the product is to be connected to a variable alternating-current source of supply. The test frequency is not to be less than three times the rated frequency of the product so that the secondary voltage of the transformer will provide the required potential without being limited by the saturation of the iron of the transformer core.

48.3.4 In the testing of rectified (d-c) secondary circuits, a high-voltage rectifier and an appropriate filter network is to be substituted for the rectifier of the product, if necessary, and the product electrolytic capacitors removed from the circuit.

48.4 Maximum voltage

48.4.1 The maximum voltage to be used as a basis for the calculation of the dielectric withstand potentials specified in 48.3.1 is to be determined in accordance with 48.4.2 and 48.4.3.

48.4.2 To obtain the maximum voltage, any combination of tubes and fuses may be removed. An automatic voltage-regulating device is to be rendered inoperative unless, upon investigation, it is found that it can be relied upon to keep the voltage from increasing. The investigation is to take into consideration any likely malfunctions in either the regulating device or the product, and the possibility of the device being disconnected, if it is not permanently connected in the circuit.

48.4.3 A connector or comparable part that is likely to be disconnected during intended operation or user servicing is to be both connected and disconnected during the test, in order that the maximum voltage may be obtained.

48.5 Induced potential

48.5.1 Three samples of a transformer as described in Exception No. 2 of 25.7 and 25.8 are to be subjected to this test. While in a heated condition from operation as described in Temperature Test, Section 47, the primary winding of each transformer shall withstand without breakdown an alternating potential of twice the rated voltage of the winding. The potential is to be applied for:

a) 7200 cycles, 120 Hz or more, and

b) 60 seconds if the test frequency is less than 120 Hz.

An increased test frequency may be necessary to prevent core saturation.

48.5.2 The test voltage is to be started at one-quarter or less of the full value and increased to full value in not more than 15 seconds. After being held for the time specified, the voltage is to be reduced within 5 seconds to one-quarter or less of the maximum value and the circuit is to be opened.

48.5.3 With reference to 48.5.1, a transformer may be conditioned in an oven to obtain the temperature reached in the Temperature Test, Section 47, before conducting the induced potential test.

49 Immersion Test

49.1 After being subjected to the immersion test described in 49.2, a line connected toothbrush or similar hand-held device shall comply with the leakage current requirements of 43.1, and the dielectric voltage-withstand requirements of 48.1.1.

49.2 Each of three samples is to be connected to a supply source as described in 41.2 and operated through repeated cycles of 5 minutes ″on″ and 5 minutes ″off″ for 7 hours. Following the last ″on″ period, and while still connected to the supply circuit, each sample is to be subjected to three 30-second immersions in a solution containing 1/2 gram of common table salt per liter of distilled water. Immediately thereafter, the samples are to be subjected to the tests outlined in 49.1 and disassembled for examination for compliance with 49.3.

49.3 The test described in 49.2 shall not result in the entrance of water into the interior of the sample in such manner that it might come into contact with uninsulated live parts or film-coated insulated wire.

50 Grounding Impedance Test

50.1 For equipment with a grounding means, the impedance at 60 Hz between the point of connection of the equipment grounding means, including the supply cord, and any other metal part that is required to be grounded, see 27.3, shall not be more than 0.1 ohm when measured in accordance with 50.2.

50.2 Compliance with 50.1 is determined by measuring the voltage when a current of 25 A, derived from a 60-Hz source with a no-load voltage not exceeding 6 V, is passed between the grounding pin of the attachment plug or other grounding means and the metal part in question.

51 Abnormal Operation Tests

51.1 General

51.1.1 A product shall not present a risk of fire or electric shock when subjected to the following tests: output loading, switch position, and component breakdown. Each abnormal test shall be followed by a dielectric voltage-withstand test as required by 48.2.1(a) applied between the transformer primary and secondary windings and between the line and exposed dead-metal parts.

51.1.2 A risk of fire or electric shock is considered to exist if any of the following occur:

a) Opening of the grounding fuse;

b) Charring of cheesecloth;

c) Emission of flame or molten material from the product enclosure and output cord, if provided;

d) Any opening that develops in the enclosure that exposes live parts at a potential of more than 42.4 V peak to any other part or to ground; or

e) Loss of structural integrity to a degree where a plug-in unit cannot be removed from a receptacle immediately after the test without deformation or a risk of electric shock.

51.1.3 Each test is to be conducted on a separate sample unless agreeable to those concerned that more than one test can be conducted on the same sample.

51.1.4 During each test, the grounding means, if provided, is to be connected to ground through a 3-A nontime-delay fuse.

51.1.5 During the tests, the unit is to be draped with a double layer of cheesecloth conforming to the outline of the product.

51.1.6 The temperatures specified are based on an assumed ambient temperature of 25°C (77°F), but a test may be conducted at any ambient temperature of 21 – 30°C (70 – 86°F). However, if the operation of an automatic thermal control during the test limits the temperatures under observation, no temperatures higher than indicated is acceptable.

51.2 Output loading test

51.2.1 A transformer shall be tested under the short circuit output condition. If this does not result in the most severe output loading, the transformer shall be tested under the most severe condition, that may be maximum obtainable output current, or either of the conditions described in 51.2.3 and 51.2.4. A fuse or overcurrent protector provided as part of the transformer is to remain in the circuit, and the largest fuse a fuseholder will accept is to be installed. However, fuses that are located so as to be accessible only to qualified service personnel and marked in accordance with 64.1, may be left in the circuit under test. The test is to be continued until the overcurrent or overtemperature protection opens, constant temperatures are attained, or the transformer winding opens. If an automatically reset protector is provided, or constant temperatures are attained, the test is to be continued for 7 hours. A manually reset protector is to be operated for 50 cycles. The protector contacts are to be operative upon completion of the test.

Exception: For the transformer mentioned in 25.4, the tests are to be continued for 15 days.

51.2.2 The product shall comply with the requirements in 51.1.1 and with the following:

a) During the short-circuit condition, the temperature on the enclosure shall not exceed 90°C (194°F); a temperature of 150°C (302°F) is acceptable if the transformer permanently opens within 1 hour after initiation of the test, if no flame or molten metal is emitted from the unit and no other risk of fire or electric shock results;

b) The grounding fuse, if required by 51.1.4, shall not open; and

c) The branch-circuit overcurrent protective device shall not open.

51.2.3 In regard to 51.2.1, for some constructions it may also be necessary to conduct the test at conditions of maximum power transfer and no secondary load to determine the most severe operating condition.

51.2.4 For transformers with more than one output, one output is to be loaded as specified in 51.2.1 while the other outputs are open circuited or loaded to rated conditions whichever results in a more severe operating condition.

51.2.5 If short circuiting causes operation of an automatically or manually reset protective device, compliance is also to be determined using the maximum load value that allows continuous operation.

51.2.6 If short circuiting causes opening of a fuse, the transformer is to be tested starting with a load current that causes a current of 110 percent of the fuse rating to flow in the fused circuit. The load current is to be increased or decreased, as may be necessary, in steps of 2 percent until a current value is obtained at which the fuse does not open in 7 hours.

51.2.7 If short circuiting causes opening of a thermal cutoff or a single-operation bimetallic device, the device is to be shunted and a thermocouple attached to its body. The load current is to be raised slowly until a temperature equal to the rated trip temperature of the device plus 5°C (9°F) is reached. Without further readjustment of the load, the unit is to be operated for the remainder of the 7 hour period.

51.2.8 If short circuiting causes opening of a winding, tests are to be conducted with the secondary winding loaded to a current (I_L) equal to the rated current (I_R) plus X percent of the difference between the short-circuit current (I_{SC}) and the rated current (I_R). In the tests, the values of X are to be 75, 50, 25, 20, 15, 10, and 5, in that order. If a load current results in 7 hours of continuous operation, further tests need not be conducted. For the tests, a variable resistance load is to be adjusted to the required value as quickly as possible and readjusted, if necessary, 1 minute after application of voltage to the primary winding.

51.3 Switch position test

51.3.1 A product employing a user adjustable primary-voltage selector switch shall be connected to the maximum test voltage and to its rated intended load. The switch is then to be adjusted to the lowest voltage position. Operation of the product is to continue:

a) Until ultimate conditions are observed,

b) For 7 hours, if cycling of an automatically reset protector occurs, or

c) For 50 cycles of resetting a manually reset protector.

51.4 Component breakdown test

51.4.1 The components in the unit, such as diodes, resistors, transistors, capacitors, and the like, are to be shorted or opened, one at a time. The product is to be connected to the maximum test voltage and operated until ultimate conditions are observed, or for 4 hours if cycling of an automatically reset protector occurs. This test need not be conducted for component breakdowns that result in open or short circuiting of the output, in short circuiting of the transformer, or for a component in a low voltage circuit.

52 Connector Cycling Test

52.1 A separable connector shall perform acceptably, without injuriously affecting any part of the device, when subjected to the specified number of cycles of make and break at six-second intervals. A connector shall be operated for 10 cycles if it is in a circuit on the load side of a transformer, and for 50 cycles if it is in the primary-input circuit.

52.2 A separable connector is considered to be one that is not held in place by a screw, clamp, or the like, and that could be separated by the user.

53 Reservoir Overflow Test

53.1 If a product incorporates a reservoir or other liquid-storage chamber that can be overfilled in intended service, liquid overflowing from the reservoir or chamber shall not wet uninsulated live parts or film-coated wires, and shall not wet electrical insulation that is likely to be adversely affected by the liquid usually used in the reservoir or chamber.

Exception: Contact of the liquid with the parts described in 53.1 is acceptable when a sample of the product is subject to the test described in 53.3 and 53.4 with acceptable results.

53.2 To determine whether a product complies with the requirement in 53.1, it is to be tested as follows; water is to be used for the test, and it is to be poured into the reservoir. The reservoir is to be filled to the level recommended, if such level is plainly marked; otherwise, the reservoir is to be filled to maximum capacity. Additional water, equal to 50 percent of the volume just mentioned, but not more than one pint, is then to be poured into the reservoir. Usually, determination of whether uninsulated live parts have become wet as a result of the overflow is to be by means of visual inspection, but this may be supplemented by a leakage-current test or a dielectric voltage-withstand test, or both, if determined to be appropriate.

53.3 Substituting a saline solution of 1/2 gram of salt per liter of water for tap water, the procedure for the overflow test is conducted as described in 53.2.

53.4 Immediately following the procedure in 53.3 the, sample is to be tightly wrapped with conductive foil so as to be in contact with all exposed surfaces, and the sample required to withstand a potential of 2500 V ac applied between the metal foil and live parts (Dielectric Voltage-Withstand Test, Section 48); and maintain a leakage current of less than 0.5 ma between the foil and ground when tested in accordance with the Leakage Current Test, Section 43.

54 Dispenser Leakage Test

54.1 A product that employs a device for dispensing a liquid and does not provide acceptable protection of live parts (14.1), shall be subject to the tests in 54.2.

54.2 With a sample of the product oriented in any position that may be encountered in normal use, an amount equal to 1/2 the capacity of the dispenser reservoir – but not more than one pint of a saline solution consisting of 1/2 gram of salt per liter of water is to be poured into the chamber or area containing any part of the dispenser.

54.3 Immediately following the procedure in 54.2, the sample is to be tightly wrapped with conductive foil so as to be in contact with all exposed surfaces, and the sample required to acceptably withstand a potential of 2500 V ac applied between the conductive foil and live parts (Dielectric Voltage-Withstand Test, Section 48); and maintain a leakage current of less than 0.5 ma between the foil and ground when tested in accordance with the Leakage Current Test, Section 43.

55 Cleaning Test

55.1 Each product, or portion of a product, that is intended to be cleaned by wiping or washing shall be conditioned as outlined in 55.2 and 55.3, after which the leakage-current test described in Leakage Current Test, Section 43 shall be repeated with no increase in the previously observed leakage current values.

55.2 For products intended to be wiped clean, the outer surface of one sample is to be wiped thoroughly with a folded cheesecloth applicator saturated in the cleaning agent specified in the instruction manual. The complete wiping procedure is to be repeated until a total of 5 operations has been completed.

55.3 For products intended to be washed, one sample of the product is to be submerged to the level indicated in a liquid bath as recommended in the instruction manual. Immersion time is to be for a total of one hour, after which the product is to be removed and dried thoroughly on the outside using a soft absorbent cheesecloth pad. The immersion and drying procedure is to be repeated until a total of 5 washings and dryings have been completed.

55.4 The cheesecloth shall be bleached, running 15 – 15 yd^2/lb (approximately 26 – 28 m^2kg) and have what is known in the trade as a ″count of 32 by 28,″ that is, for any square inch, 32 threads in one direction and 28 threads in the other direction (for any square centimeter, 13 threads in one direction and 11 in the other direction).

56 Thermostats Test

56.1 General

56.1.1 Unless it has been tested and found acceptable for the application, a thermostat shall acceptably complete the test program outlined in 56.2.1 – 56.3.2.

56.2 Overload

56.2.1 An automatic control for temperature regulating or temperature limiting shall be capable of performing successfully for 50 cycles of operation when the product is connected to a supply circuit having a potential of 120-percent of the voltage specified in 41.2. There shall be neither electrical nor mechanical malfunction of the control, nor undue burning, pitting, or welding of the contacts.

56.2.2 In a test to determine whether an automatic control complies with the requirements in 56.2.1, the product is to be connected to a grounded supply circuit; the enclosure of the product, if of metal, is to be connected to ground through a 3-A fuse; and the control, if single-pole, is to be connected in an ungrounded conductor of the circuit. The control is to be operated at the rate of ten cycles per minute, except that a faster rate of operation may be employed if agreeable to all concerned. The performance is unacceptable if the fuse in the grounding connection opens during the test.

56.3 Endurance

56.3.1 A thermostat shall be capable of withstanding an endurance test that shall consist of the number of cycles indicated in Table 56.1. Unless it is specified that the test be made without load, the thermostat shall make and break its expected load in the product while connected to a circuit of rated voltage. There shall be neither electrical nor mechanical malfunction of the thermostat, nor undue burning, pitting, or welding of the contacts.

56.3.2 With reference to 56.3.1 and Table 56.1, thermostats are classified as follows:

a) A temperature-regulating thermostat is one that functions only to regulate the temperature of the heating element under intended conditions of use and whose malfunction would not result in a risk of fire.

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

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

Table 56.1
Number of cycles of operation for endurance test

Type of thermostat	Automatically reset thermostat	Manual reset thermostat
Temperature-regulating	A number of cycles equivalent to 1000 hours of normal operation of the product, but not less than 30,000. However, the test may be omitted if, with the thermostat short-circuited, no temperatures higher than the limits given in Table 47.1 are attained during the normal temperature test of the product.	To be made the subject of special consideration. No value is specified because of unlikely use.
Temperature limiting	A number of cycles equivalent to 100 hours of operation of the product under any condition which causes the thermostat to function, or 100,000 cycles, whichever is greater. However, the test may be omitted if, with the thermostat short-circuited there is no evidence of risk of fire as described in 51.1.1 – 51.1.6 during the continuous abnormal operation of the product.	1000 cycles under the load and 5000 cycles without load. However, the test may be omitted if, with the thermostat short-circuited, there is no evidence of risk of fire as described in 51.1.1 – 51.1.6 during continuous abnormal operation of the product.
Combination temperature-regulating and -limiting	100,000 cycles if, with the thermostat short-circuited, there is evidence of a risk of fire as described in 51.1.1 – 51.1.6. If there is no evidence of risk of fire under this condition, the thermostat is to be tested as a temperature-regulating thermostat. (See above).	To be made the subject of special investigation. No value is specified because of unlikely use. Combination temperature-regulating and- limiting

57 Printed Wiring Assemblies Test

57.1 Dielectric voltage-withstand test

57.1.1 Where electrical breakdown would result in risk of electric shock, a printed wiring assembly shall be capable of withstanding without breakdown for a period of 1 minute the application of a direct potential of 2E + 1000 V between printed wiring parts and between printed wiring parts and other parts.

57.1.2 E is the maximum peak potential between parts measured with the product connected to a supply circuit and operated under the conditions described in 48.4.2 and 48.4.3.

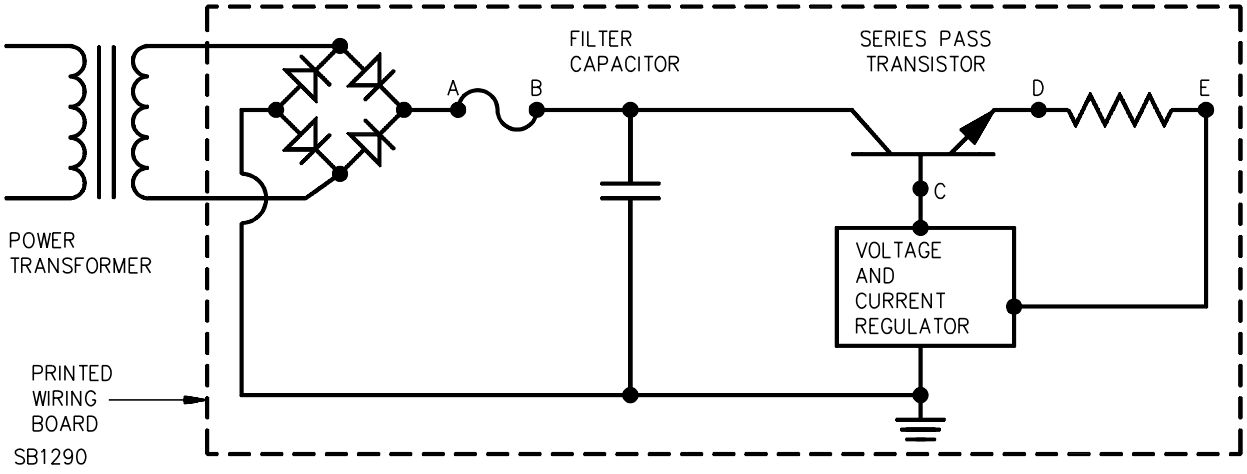
57.2 Limited power test

57.2.1 Unless the sources of power for printed wiring assemblies are limited so that they are not capable of delivering power of 50 W (or more) for more than one minute into an external resistor connected between any two points on a complete assembly, the assembly shall comply with the requirements of 57.3.1 and 57.4.1.

Exception: A printed-wiring assembly that complies with 57.2.3 need not comply with 57.3.1

Figure 57.1
Power supply test example illustrating method of determination of the ″less than 50 Watt″ points

Figure 57.1 revised August 4, 1998



Example No. 1 – Refer to Figure 57.1 as an example illustrating the method of determining the points referred to in 57.2.1. Assume that the maximum readings of power delivered to a variable external resistive load connected singly between the power supply return and the points A and B are 50 plus and 40, respectively. The opening of the secondary fuse occurred at the 40 W point. Since the power reading at point B is less than 50 W, this is the point to be short-circuited and loaded to the maximum available power. Additionally, a single diode in the bridge rectifier is short circuited as this is a component between the first point less than 50 W and the supply circuit.

Example No. 2 - Now consider that the maximum reading variable resistive load connected between the power supply return and points C, D and E are: 50 W plus, 50 W plus, and 20 W respectively. Since the reading at point E is less than 50 W, this is the point to be short circuited and loaded to the maximum power. Shorting of the components back to the source of supply includes the series pass transistor, the voltage regulator, the first filter capacitor and a single diode in the bridge rectifier.

57.2.2 It is not necessary that a printed wiring assembly be regarded as a unit in applying the requirement in 57.2.1. For example, a part of the assembly may comply with 57.2.1, another part with 57.3.1 and the dielectric voltage-withstand test in 57.4.2 and 57.4.3, and another part with 57.3.1 and the arcing test in 57.4.4.

57.2.3 A printed-wiring assembly need not comply with the requirement of 57.3.1, as mentioned in the exception to 57.2.1, provided the printed-wiring assembly is powered from a secondary winding of an isolating transformer and the printed-wiring board of the assembly has a minimum flame classification of V-2 (as determined from the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94). The enclosure of such printed-wiring assemblies is to comply with (d), and either (a), (b), or (c) as follows:

a) Enclosure is to be made of metal. See Frame and Enclosure, Section 8.

b) Enclosure is to be made of a polymeric material having a minimum flame classification of V-1.

c) Enclosure is to be made of solid or laminated wood, at least 3/8 inch (9.5 mm) thick with no edge exposed to internal electrical parts and spaced at least 1/2 inch (12.7 mm) from arcing parts and sources of ignition. Parts considered to be sources of ignition are those connected in circuits having a capability of over 50 W and include resistor body, transistor body, diode body, inductor body (coil only), capacitor body, transformer (coil only), and integrated circuits.

d) Openings in the enclosure:

1) Are not to project vertically onto a horizontal plane above the product,

2) That are in the sides, are not to have a maximum minor dimension more than 1/8 inch (3.2 mm), and

3) That are in the bottom, are to be protected by a solid barrier or screen complying with 8.17 and that extends not less than 1 inch (25.4 mm) beyond the horizontal projection. A screen is to be 20 AWG (0.52 mm^2) mesh or equivalent with the maximum dimension of openings not greater than 3/32 inch (2.4 mm). A barrier is to be of metal not less than 0.014 inch (0.36 mm) thick, polymeric material having a minimum flammability classification of V-1, or wood not less than 3/8 inch (9.5 mm) thick.

57.2.3 revised August 6, 2004

No Text on This Page

57.3 Abnormal operation test

57.3.1 If the sources of power for a printed wiring assembly are not limited as described in 57.2.1, the assembly shall not produce risk of fire under both of the following conditions:

a) The short circuiting of those points of the power supply nearest the supply circuit that are not capable of delivering a power of 50 W (or more) for a period of 1 minute into an external resistor. When the condition of short circuiting results in the malfunction of a component or the rendering of a circuit inoperative, such as the biasing-off of a transistor, a condition of loading to maximum power is also to be conducted between those points.

b) The short circuiting (singly) of any rectifier, vacuum tube, transistor, or electrolytic capacitor in the circuit between the points mentioned in (a) and the supply circuit.

57.3.2 The reference to the external resistor in 57.2.1 and 57.3.1 is generally a variable resistor that can be adjusted so that the resistance equals the resistive portion of the characteristic impedance of the circuit in question, and hence, the maximum power availability can be determined. The desired setting of the external variable resistor can be found with the aid of a wattmeter or the plotting of a volt-ampere curve from several settings of the variable resistive load.

57.3.3 In conducting the test described in 57.3.1, a single layer of cheesecloth is to be loosely draped over the product as a whole, with the cloth within 1/8 inch (3.2 mm) of openings in the overall enclosure. A cord-connected product is to be placed on a white tissue paper covered softwood surface. The test is to be continued until a fire has been developed, the circuit under test burns open, or until no further change is likely to take place, but in no case for more than 7 hours. The results are unacceptable if the cheesecloth or tissue paper glows or flames.

57.4 Dielectric voltage-withstand or arcing test

57.4.1 If the sources of power for a printed wiring assembly are not limited as described in 57.2.1, the assembly shall be capable of withstanding:

a) A second dielectric voltage-withstand test as described in 57.4.2 and 57.4.3 or

b) An arcing test as described in 57.4.4.

57.4.2 For the second dielectric voltage-withstand test the printed wiring assembly is to be subjected to a direct potential of 2E + 1000 V, see 57.1.2, between parts of different potential on the assembly where electrical breakdown involves a path over the surface of insulating material. Compliance is determined by maintaining the dielectric withstand for one minute without breakdown.

57.4.3 At the option of those concerned, components need not be provided on the printed wiring boards subjected to the test outlined in 57.4.2 as it is a test of spacings on the printed foil pattern. Boards submitted for test should have been subjected to the production soldering process, however.

57.4.4 For the arcing test on the printed wiring assembly, with the complete product connected to a supply source in accordance with 41.2, and using the energy available, an arc is to be drawn over the surface of the insulating material between parts of different polarity by means of a carbon probe. The arc is to be maintained for a period of 15 minutes unless the circuit is interrupted by malfunction of a component, such as a resistor in a shorter time. If the circuit is interrupted by malfunction of a component, the test is to be repeated twice using new components for each test. Compliance is determined by discontinuation of any flaming of the material within one minute after interruption or discontinuation (15 minutes) of the test.

58 Strain Relief Test

58.1 Supply cord test

58.1.1 The strain relief means provided on an attached flexible cord, when tested in accordance with 58.1.2, shall withstand for 1 minute without displacement a direct pull of 35 lbf (156 N) applied to the cord, with the connections within the product disconnected.

58.1.2 A 35-lb (15.9 kg) weight is to be suspended on the cord and supported by the product so that the strain-relief means will be stressed from any angle that the construction of the product permits. The strain relief is not acceptable if, at the point of disconnection of the conductors, there is such movement of the cord as to indicate that stress would have resulted on the connections.

58.2 Output or interconnecting cable strain relief test

58.2.1 When tested in accordance with 58.2.2, the strain relief means and an output cord or interconnecting cable shall withstand a direct pull of 20 lbf (89 N) applied to the cord or cable, for 1 minute without displacement or breakage of the cord, or cable, or deformation of its anchoring surface.

58.2.2 The 20 lbf (89 N) force is to be applied to the cord, or cable, and supported by the product so that the strain-relief means is stressed from the most severe angle that the construction of the product permits.

MANUFACTURING AND PRODUCTION TESTS

59 Dielectric Voltage-Withstand Test

59.1 Each product shall withstand without an indication of unacceptable performance, as a routine production-line test, the application of a 40 – 70 Hz potential between:

a) The primary wiring, including connected components, and accessible dead metal parts that are likely to become energized, and

b) Between primary and accessible low voltage (42.4 V peak or less) metal parts, including terminals, and

c) Between the primary wiring, including components, and metal foil wrapped around a polymeric enclosure. For a definition of unacceptable performance see 59.8(d).

59.2 The production-line test shall be in accordance with either condition A or condition B of Table 59.1.

Table 59.1
Production-line test conditions

Product rating and form	Condition A		Condition B	
	Potential volts	Time – seconds	Potential volts	Time – seconds
105 – 130V with or without a motor rated 1/2 hp (373 W) or less and not applied to or contacted by persons in normal use.	1000	60	1200	1
105 – 130V and applied to or contacted by persons in the intended use or with a motor rated more than 1/2 hp (373 W)	1000 + 2V[a]	60	1200 + 2.4V[a]	1
210 – 600V	1000 + 2V[b]	60	1200 + 2.4V[b]	1
Patient connected circuits (regardless or voltage rating)[c]	2500	60	3000	1

[a] Maximum marked voltage, but not less than 120 V.
[b] Maximum marked voltage but not less than 240 V.
[c] Applied between primary circuits and patient connections only.

59.3 The product may be in a heated or unheated condition for the test.

59.4 The test shall be conducted when the product is complete (fully assembled). It is not intended that the product be unwired, modified or disassembled for the test.

Exception No. 1: Parts such as snap covers or friction-fit knobs that would interfere with performance of the test need not be in place.

Exception No. 2: The test may be performed before final assembly if the test represents that for the completed product.

59.5 When the product employs a solid-state component that is not relied upon to reduce the risk of an electric shock and that can be damaged by the dielectric potential, the test may be conducted before the component is electrically connected provided that a random sampling of each day's production is to be tested at the potential specified in Table 59.1. The circuitry may be rearranged for the purpose of the test to minimize the likelihood of solid-state-component damage while retaining representative dielectric stress of the circuit.

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

a) If the test duration is 1 second, the output voltage is to be maintained within the specified range,

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

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

b) If the test duration is 1 minute, the output voltage is to be maintained within the specified range, by manual or automatic means, throughout the 1 minute duration of the test or until there is an indication of unacceptable performance.

59.7 The specified control of the applied voltage, manual or automatic, shall be maintained under conditions of varying line voltage. Higher test potentials may be used if the higher dielectric stress is not likely to adversely affect the insulating system of the product.

59.8 In addition to the characteristics indicated in 59.6, the test equipment is to have the following features and characteristics:

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

b) An output voltage that:

1) Has a sinusoidal waveform,

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

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

c) A means of effectively indicating unacceptable performance. The indication is to be:

1) Auditory if it can be readily heard above the background noise level,

2) Visual if it commands the attention of the operator, or

3) A device that automatically rejects an unacceptable product. If the indication of unacceptable performance is auditory or visual, the indication is to remain active and conspicuous until the test equipment is reset manually.

d) When the test equipment is adjusted to produce the test voltage and a resistance of 120,000 ohms is connected across the output, the test equipment is to indicate an unacceptable performance within 0.5 second. A resistance of more than 120,000 ohms may be used to produce an indication of unacceptable performance, if the manufacturer elects to use a tester having higher sensitivity.

59.9 There is not to be any transient voltage applied to the appliance under test that results in the instantaneous voltage applied to the product exceeding 120 percent of the peak value of the test voltage that the manufacturer elects to use for this test. This requirement applies for the entire duration of the test, including the time that the voltage is first applied to the product and the time that the voltage is removed from the product.

59.10 During the test, a sufficient number of primary switching components shall be in the on position so that all primary circuitry will be stressed. Both sides of the primary circuit of the product are to be connected to one terminal of the test equipment. The second test equipment terminal is to be connected to accessible dead metal.

60 Grounding Continuity Test

60.1 Each product that has a power supply cord having a grounding conductor shall be tested, as a routine production line test, to determine grounding continuity between the grounding blade of the attachment plug and the accessible dead metal parts of the product that are likely to become energized.

60.2 Only a single test need be made if the accessible metal selected is conductively connected by construction to all other accessible metal.

60.3 Any effective indicating device – an ohmmeter, a battery and buzzer combination, or the like — may be used to determine compliance with the grounding continuity requirement in 60.1.

RATINGS

61 Details

61.1 A product shall be rated:

a) In amperes or watts,

b) In volts, and

c) For alternating current only or direct current only.

The rating shall include the frequency if needed for a motor, relay coil or other component.

61.2 The current rating of a product shall include 15 A for a single receptacle provided as part of the product and intended for use as a general use outlet, 20 A for two or more receptacles, including a single duplex receptacle, or, if the outlet is marked as noted in 62.1.5, that marked rating shall be included in the current rating of the product.

MARKINGS

62 Details

62.1 General

62.1.1 A product shall have a plain and legible marking. The marking shall be readily visible after installation in the case of a permanently-connected product. The marking shall include:

a) The manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified,

b) The day or other dating period of manufacture not exceeding any three consecutive months,

c) The catalog number or the equivalent, and

d) The electrical rating.

Exception No. 1: The date of manufacture may be abbreviated in a nationally accepted conventional code, or in a code affirmed by the manufacturer.

Exception No. 2: The marking may be located where visible behind a cover that is movable without the use of a tool. If the cover is removable the marking shall be on other than the cover.

62.1.2 The repetition time cycle of a date code shall be not less than 10 years. The date code shall not require reference to the manufacturer's records to determine when the product was manufactured.

62.1.3 A ″CAUTION″, ″WARNING″, or ″DANGER″ marking shall be:

a) Paint-stenciled, die-stamped, molded, or indelibly stamped,

b) In the form of pressure-sensitive labels, or

c) In a form that has been determined to be the equivalent.

A pressure-sensitive label, if used, shall comply with the requirements in the Standard for Marking and Labeling Systems, UL 969.

62.1.4 Block lettering shall be used for the marked word ″CAUTION″, ″WARNING″, or ″DANGER″.

62.1.5 A product provided with general use receptacles intended for limited current loads shall have each such receptacle permanently marked ″___amperes, maximum, ___watts, maximum″, or equivalent, adjacent to the receptacle.

62.1.6 If a manufacturer produces or assembles products at more than one factory, each product shall have a distinctive marking, that may be in code, by which it may be identified as the product of a particular factory.

62.1.7 Equipment that complies with the requirements for double insulation systems for use in electrical equipment, UL 1097, shall be permanently marked with the words ″Double Insulation – When servicing, use only identical replacement parts.″ The words ″Double-Insulated″ may be used instead of ″Double Insulation″ in the marking.

62.1.8 The double-insulation symbol (a square within a square) may be used in addition to but not in place of the words ″Double Insulation″.

62.2 Permanently-connected products

62.2.1 If any point within a terminal box or wiring compartment of a permanently-connected product in which the power-supply conductors are intended to be connected, including such conductors themselves, attains a temperature of more than 60°C (140°F) during the temperature test, the product shall be permanently marked ″For supply connection, use wires acceptable for at least ... C (... F),″ or with an equivalent statement, and the temperature value shall be in accordance with Table 62.1. This statement shall be located at or near the point where the supply connections are to be made, and shall be clearly visible both during and after installation of the product.

Table 62.1
Outlet-box marking

Temperature attained during test in terminal box or compartment	Temperature marking
61 – 75°C (142 – 167°F)	75°C (167°F)
76 – 90°C (168 – 194°F)	90°C (194°F)

63 Servicing

63.1 The extent of user or operator servicing is defined in 2.13. To deter attempts at further servicing of the product by unqualified personnel that will result in the exposure of live parts, a caution notice shall be provided on the product where readily visible during any approach to attempt servicing. The marking shall consist of the word ″CAUTION″ and the following wording or equivalent – ″Risk of electric shock, do not remove cover (or back). Refer servicing to qualified service personnel″.

64 Fuse Replacement

64.1 There shall be a legible and durable marking for each fuse used to meet the requirements in this standard indicating the ampere rating (and voltage if more than 125 V) of the fuse to be used for replacement. The marking is to be located so that it is obvious to which fuse or fuseholder the marking applies. In addition, the word ″WARNING″ and the following or the equivalent shall be provided – ″For continued protection against risk of fire, replace only with same type and rating of fuse″.

65 Oxygen

65.1 Oxygen enrichment or oxygen-administering equipment shall be marked ″WARNING″ – and the following wording or equivalent, ″RISK OF FIRE – Keep matches, lighted cigarettes, and all other sources of ignition out of the room in which the product is located. Textiles, oils, and other combustibles are easily ignited and burn with great intensity in air enriched with oxygen.″ The letter height shall not be less than 7/64 inch (2.8 mm) for the word ″WARNING″ and the first sentence of the above notice, and not less than 3/32 inch (2.4 mm) for the remainder of the notice.

65.2 Additional statements relating to the use of oxygen (see 67.1) shall be contained in the operating instructions accompanying each product.

USE AND CARE INSTRUCTIONS

66 General

66.1 A product shall be provided with a user instruction manual that warns the operator of reasonably foreseeable uses or misuses so as to reduce the risk of fire, electric shock, and injury to persons:

a) The instructions shall be legible and contrast with the background. Upper case letters in the instructions shall be not less than 5/64 inch (2.0 mm) high, and lower case letters shall be not less than 1/16 inch (1.6 mm) high. The heading ″IMPORTANT SAFEGUARDS″ and ″SAVE THESE INSTRUCTIONS″ shall be in letters at least 3/16 inch high. ″READ ALL INSTRUCTIONS BEFORE USING″ and ″DANGER″ shall be in letters at least 5/64 inch (2.0 mm) high, but less than 3/16 inch (4.8 mm) high.

b) The instructions shall:

1) Be in the first part of the manual,

2) Be before the operating instructions,

3) Be separate in format from other detailed instructions related to assembly, operation and maintenance, and

4) Be a permanent part of the manual.

66.2 The manual shall include the instructions specified in 67.1 and the appropriate instructions in 67.3 and in User Instructions, Section 68 and Grounding Instructions, Section 69.

66.3 The instruction manual shall include instructions or illustrations to identify important parts of the product. Illustrations may be used with a required written instruction to clarify its intent, but shall not be used in place of a required written instruction.

66.4 Unless otherwise indicated, the instructions shall be in the exact words specified or shall be in equally definitive terminology.

Exception: Specified wording that is not appropriate for a product or part being judged may be omitted, or may be changed as found to be necessary for that product or part.

66.5 Wording in parentheses in Sections 66 – 71 is explanatory, indicating options, alternatives, or cross-references. Wherever the words ″the (or this) product″ are used, the name of the specific product may be substituted in the final text.

66.6 The items may be numbered. In the list of items the first shall be ″READ ALL INSTRUCTIONS BEFORE USING THE APPLIANCE″, and the last shall be ″SAVE THESE INSTRUCTIONS″. Other important and precautionary items considered appropriate by the organization responsible for the product may be inserted.

67 Warning Instructions

67.1 User instructions may be numbered. ″READ ALL INSTRUCTIONS BEFORE USING″ shall precede the list of items following the word ″DANGER,″ and ″SAVE THESE INSTRUCTIONS″ shall be last. The sequence of the instructions of 67.1 under the word ″DANGER″ should follow the expected sequence of user exposure to the situation during use of the product such as to address the most important item first, and, in descending order, the remaining instructions. The other items in 67.3 should follow in the stipulated sequence. Other instructions pertaining to the risk of fire, electric shock, or injury to persons that the organization responsible for the product considers to be needed may be included.

IMPORTANT SAFEGUARDS

When using electrical products, especially when children are present, basic safety precautions should always be followed, including the following:

READ ALL INSTRUCTIONS BEFORE USING

DANGER – To reduce the risk of electrocution:

1. Always unplug this product immediately after using.

Exception: Battery chargers while recharging batteries and permanently connected products such as toilet seat assemblies.

2. Do not use while bathing.

Exception: Hydromassage units and similar products.

3. Do not place or store product where it can fall or be pulled into a tub or sink.

4. Do not place in or drop into water or other liquid.

5. Do not reach for a product that has fallen into water. Unplug immediately.

WARNING – To reduce the risk of burns, electrocution, fire, or injury to persons.

1. A product should never be left unattended when plugged in.

Exception: Contact lens disinfectors, toilet seat assemblies, and similar products.

2. Close supervision is necessary when this product is used by, on, or near children or invalids.

3. Use this product only for its intended use as described in this manual. Do not use attachments not recommended by the manufacturer.

4. Never operate this product if it has a damaged cord or plug, if it is not working properly, if it has been dropped or damaged, or dropped into water. Return the product to a service center for examination and repair.

5. Keep the cord away from heated surfaces.

6. Never block the air openings of the product or place it on a soft surface, such as a bed or couch, where the air openings may be blocked. Keep the air openings free of lint, hair, and the like.

7. Never use while sleeping or drowsy.

Exception: Alternating pressure point pad control units and the like.

8. Never drop or insert any object into any opening or hose.

9. Do not use outdoors or operate where aerosol (spray) products are being used or where oxygen is being administered.

Exception: Oxygen therapy equipment.

10. Connect this product to a properly grounded outlet only. See Grounding Instructions.

Exception: A cord-connected product that is not provided with a means for grounding or a product intended for permanent connection.

11. Unplug this product before filling. Fill (reservoir) with water only unless otherwise specified by manufacturer. Do not overfill (or specify filling instructions).

Exception: The instructions for a product with a separable water reservoir need only include "Fill reservoir with water only unless otherwise specified by manufacturer."

SAVE THESE INSTRUCTIONS

67.2 Instructions in addition to those specified in 67.1 are not required unless specifically indicated.

67.3 As applicable, the following instructions shall be included in addition to the instructions in 67.1:

For oxygen therapy equipment:

12. The use of oxygen in therapy requires that special care be taken to reduce the risk of fire. Any materials which will burn in air and some that will not are easily ignited and burn rapidly in high concentrations of oxygen. Accordingly, for safety it is necessary that all sources of ignition be kept away from the product and preferably out of the room in which it is being used. "NO SMOKING" signs should be prominently displayed.

13. A spontaneous and violent ignition may occur if oil, grease or greasy substances come in contact with oxygen under pressure. These substances must be kept away from oxygen regulators, cylinder valves, tubing and connections, and all other oxygen equipment.

68 User Instructions

68.1 Immediately following the warning instructions specified in 67.1 and the appropriate specific instructions in 67.3, the instruction manual shall include the following:

a) Instructions and caution statements for cleaning, user maintenance, operations recommended by the manufacturer, such as lubrication or nonlubrication, and a warning to the user that any other servicing should be performed by an authorized service representative or that the product has no user serviceable parts. The manual or other literature packaged with the product shall also indicate the product is for household use.

b) In the case of a product employing an automatically reset thermal limiter, that shuts off the entire product, instructions to the user on what to expect in the event the thermal limiter operates.

c) Specific instructions for the proper method of cord storage, total product storage, and the like when the product is not in use; and for cord care while in use, such as for hand supported products, untwisting, and the like.

d) In the case of a product intended to be used with water, additives, conditioners, or other solutions with or without water, or a product that relies on the conductivity of water for normal operation (electrode type product), and for which the use of baking soda, salt, or other substances to improve the conductivity of the water is stipulated, specific instructions on the proper liquid or additive to use and the exact amount to be used in conjunction with the product.

e) In the case of a dual voltage product with a voltage selector switch, instructions to the user on how to change the voltage selector switch setting and proper adaptors to be employed.

69 Grounding Instructions

69.1 The instruction manual shall include those instructions in (a) – (e) applicable to the product. The word ″**DANGER**″ shall be entirely in block letters.

a) For all grounded, cord connected products:

GROUNDING INSTRUCTIONS

This product should be grounded. In the event of an electrical short circuit, grounding reduces the risk of electric shock by providing an escape wire for the electric current. This product is equipped with a cord having a grounding wire with a grounding plug. The plug must be plugged into an outlet that is properly installed and grounded.

DANGER – Improper use of the grounding plug can result in a risk of electric shock.

If repair or replacement of the cord or plug is necessary, do not connect the grounding wire to either flat blade terminal. The wire with insulation having an outer surface that is green with or without yellow stripes is the grounding wire.

Check with a qualified electrician or serviceman if the grounding instructions are not completely understood, or if in doubt as to whether the product is properly grounded.

b) For a grounded, cord connected product rated 15 A or less and intended for use on a nominal 120 V supply circuit:

This product is for use on a nominal 120 V circuit, and has a grounding plug that looks like the plug illustrated in sketch A in Figure 69.1. A temporary adapter, which looks like the adapter illustrated in sketches B and C, may be used to connect this plug to a 2-pole receptacle as shown in sketch B if a properly grounded outlet is not available. The temporary adapter should be used only until a properly grounded outlet (sketch A) can be installed by a qualified electrician. The green colored rigid ear, lug, and the like extending from the adapter must be connected to a permanent ground such as a properly grounded outlet box cover. Whenever the adapter is used, it must be held in place by the screw.

c) For all other grounded, cord connected products:

This product is factory equipped with a specific electric cord and plug to permit connection to a proper electric circuit. Make sure that the product is connected to an outlet having the same configuration as the plug. No adapter should be used with this product. Do not modify the plug provided — if it will not fit the outlet, have the proper outlet installed by a qualified electrician. If the product must be reconnected for use on a different type of electric circuit, the reconnection should be made by qualified service personnel.

d) Extension Cords:

If it is necessary to use an extension cord, use only a three wire extension cord that has a three-blade grounding plug, and a three-slot receptacle that will accept the plug on the product. Replace or repair a damaged cord.

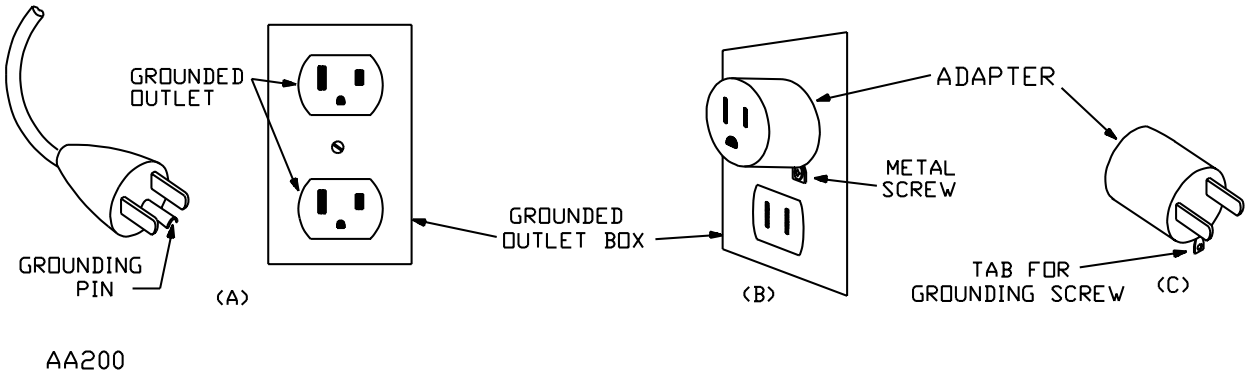
e) For a permanently connected product:

GROUNDING INSTRUCTIONS

This product should be connected to a grounded, metallic, permanent wiring system, or an equipment-grounding conductor should be run with the circuit conductors and connected to the equipment grounding terminal or lead on the product.

Figure 69.1
Grounding methods

Figure 69.1 revised August 4, 1998



69A Two-Wire Polarized Attachment Plug Instructions

Added Section 69A effective August 2, 2001

69A.1 For an appliance required to have a polarized plug, the following instructions shall be provided: "This appliance has a polarized plug (one blade is wider than the other). As a safety feature, this plug will fit in a polarized outlet only one way. If the plug does not fit fully in the outlet, reverse the plug. If it still does not fit, contact a qualified electrician. Do not attempt to defeat this safety feature."

HYDROMASSAGE UNITS

70 General

70.1 The requirements in Sections 71 – 73 supplement and, in some cases, modify the general requirements in Sections 6 – 69A.

71 Construction

71.1 General

Added Section 71.1 effective April 23, 2004

71.1.1 A hydromassage unit shall not have provision for connection to the household plumbing system.

71.1 renumbered as 71.1.1 effective April 23, 2004

71.1.2 A hydromassage unit shall be provided with a ″non-detachable″, Type SJE, SJT, or SJO or heavier power supply cord that is a minimum of 10 feet (3.0 m) in length.

Exception: For a floor mounted air blower type air hydromassager the power supply cord can be type SPT-2, NISPT-2, SVT or the equivalent.

71.1.2 revised March 26, 2007

71.1.3 (71.3) Deleted effective April 23, 2004

71.1.4 A grounding conductor provided as a part of the power supply cord described in 71.1.2 shall be connected to inaccessible dead metal parts. See 8.10 – 8.12.

71.4 revised and renumbered as 71.1.4 effective April 23, 2004

71.1.5 Any dead-metal part that is likely to become energized shall be inaccessible to contact by the user. See 8.10 – 8.12

71.5 renumbered as 71.1.5 effective April 23, 2004

71.1.6 The construction of hydromassage units shall be such that all electrical components are located outside the bathtub confines after mounting.

71.6 renumbered as 71.1.6 effective April 23, 2004

71.1.7 The center of balance shall be such that the product would not fall into the tub if the securing means were loosened.

71.7 renumbered as 71.1.7 effective April 23, 2004

71.1.8 A hydromassage unit shall be constructed so that water does not contact live parts, wiring, or inaccessible dead metal parts that are likely to become energized under each of the conditions (a) – (c) outlined below:

a) The unit is to be placed in its operating position on a tub filled with a saline solution of 1/2 gram of common table salt per liter of distilled water to a level just below overflow, and the motor operated so as to cause a surging action of the water,

b) The unit is to be splashed with one pint (473 ml) of the saline solution described above, expelled from an open beaker, onto the top and any side of the unit, and

c) The unit is to be placed in an overturned position, after being removed from a tub filled with the saline solution.

71.8 renumbered as 71.1.8 effective April 23, 2004

71.1.9 Under each of the conditions stated in 71.1.8 (a) – (c), a hydromassage unit shall comply with the applicable requirements for the Dielectric Voltage-Withstand Test (Section 48) and the Leakage Current Test (Section 43).

71.9 renumbered as 71.1.9 effective April 23, 2004

71.2 Cord-Connected Hydromassage Unit Immersion Protection

Added 71.2 effective April 23, 2004

71.2.1 A cord-connected hydromassage unit shall be constructed to reduce the risk of electric shock when the appliance is energized, with its power switch in either the ″on″ or ″off″ position, and immersed in water having an electrically conductive path to ground.

Added 71.2.1 effective April 23, 2004

71.2.2 Compliance with 71.2.1 may be accomplished with the use of an:

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

b) Integral immersion-detection circuit-interrupter (IDCI), or

c) Integral protective device of another type, such as an ALCI (Appliance Leakage-Current Interrupter), that de-energizes all current-carrying parts (hereafter referred to as a protective device) when the free-standing hydromassage unit is immersed in water having an electrically conductive path to ground.

Added 71.2.2 effective April 23, 2004

71.2.3 If a free-standing hydromassage unit is provided with a GFCI, the GFCI shall comply with the requirements for Class A cord-connected GFCIs in the Standard for Ground-Fault Circuit-Interrupters, UL 943.

Added 71.2.3 effective April 23, 2004

71.2.4 If a hydromassage unit is provided with an IDCI, the IDCI shall comply with the Standard for Immersion-Detection Circuit-Interrupters, UL 1664. An IDCI need not provide protection under the condition that any circuit conductor on the line side of the IDCI is open circuited. The combination of the hydromassage unit and the IDCI shall comply with the construction requirements specified in Section 71.3, the performance requirements in Sections 72.4 – 72.6, the marking and instruction requirements in Section 73.

Added 71.2.4 effective April 23, 2004

71.2.5 If a hydromassage unit is provided with a protective device other than a GFCI or an IDCI, the protective device shall be investigated and determined to be acceptable for the application. Investigation of the protective device shall include, but need not be limited to, consideration of:

a) Electrical rating,

b) Operating temperatures,

c) Reliability of operation,

d) Resistance to the effects of abnormal operating conditions,

e) Resistance to mechanical abuse,

f) Resistance to electrical transients, and

g) Resistance to moisture.

The combination of the hydromassage unit and protective device shall comply with the test described in the Immersion-Detection Circuit-Interrupter (IDCI) Trip Time Measurement Test, Section 72.4.

Exception: A protective device is deemed acceptable for the application if it complies with the requirements for Class A cord-connected GFCIs in the Standard for Ground-Fault Circuit-Interrupters, UL 943, except that it is not required to:

a) Have a grounding conductor;

b) Have the same type of power supply cord;

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

d) Provide grounded neutral protection by compliance with the High-Resistance Ground Faults Test, under the test condition that the neutral conductor is grounded at a point in the load circuit.

Added 71.2.5 effective April 23, 2004

71.2.6 A GFCI, IDCI, or other protective device shall be integral with the attachment plug of the power-supply cord of the hydromassage unit.

Added 71.2.6 effective April 23, 2004

71.2.7 A user-resettable protective device shall incorporate a supervisory circuit as described in Immersion- Detection Circuit-Interrupters (IDCIs), Section 71.3, for IDCIs or as described in the Standard for Ground-Fault Circuit-Interrupters, UL 943, for GFCIs.

Exception: A user-resettable protective device may be provided with a reset feature not having a test function based on all of the following:

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

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

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

Added 71.2.7 effective April 23, 2004

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

Added 71.2.8 effective April 23, 2004

No Text on This Page

71.2.9 After a protective device de-energizes current-carrying parts, it shall not automatically reset.

Added 71.2.9 effective April 23, 2004

71.3 Immersion-Detection Circuit Interrupters (IDCIs)

Added 71.3 effective April 23, 2004

71.3.1 If a hydromassage unit is provided with a resettable IDCI, the IDCI shall be provided with a supervisory circuit that tests the ability of the IDCI to interrupt all power to the appliance. The supervisory circuit shall test the continuity of the sensor conductor in an interconnecting cord between the hydromassage unit and the IDCI and operation of the IDCI. This will usually necessitate that the test switch be in the enclosure of a hydromassage unit.

Exception: A user-resettable IDCI may be provided with a reset feature not providing a test function when:

a) The IDCI complies with the Standard for Immersion-Detection Circuit-Interrupters, UL 1664, applicable to resettable IDCIs not provided with a supervisory circuit;

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

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

Added 71.3.1 effective April 23, 2004

71.3.2 With regard to 71.3.1, a tool shall not be used to operate the supervisory circuit.

Added 71.3.2 effective April 23, 2004

71.3.3 The results of the test required in 71.3.1 shall be indicated by means of an audible, visible, or audible and visible signal.

Added 71.3.3 effective April 23, 2004

71.3.4 A resettable IDCI shall be trip-free. That is, the automatic tripping shall be independent of the manipulation or position of the reset button, handle, or lever of the IDCI.

Added 71.3.4 effective April 23, 2004

71.3.5 For the purpose of applying electrical spacing requirements, the sensor conductor within the hydromassage unit shall be deemed an uninsulated live part of opposite polarity in relationship to all other live parts and to accessible dead metal parts.

Added 71.3.5 effective April 23, 2004

71.3.6 The interconnecting cord between an IDCI and the appliance enclosure shall be at least the equivalent of the supply cord.

Exception: The size of the conductor used as the sensor conductor may be smaller than 18 AWG (0.82 mm^2), but no smaller than 24 AWG (0.21 mm^2).

Added 71.3.6 effective April 23, 2004

71.3.7 A conductive coating provided as the sensor for an IDCI shall be free of wrinkles, pits, cracks, peeling, and similar defects. The coating shall be applied in a consistently uniform width and thickness

Added 71.3.7 effective April 23, 2004

71.3.8 A sensor that is in the form of a conductive coating shall comply with the Conductive Coating Test, Section 72.6.

Added 71.3.8 effective April 23, 2004

71.3.9 The material, construction, and location of a sensor shall be such that the intended functioning of the IDCI will not be adversely affected by corrosion, exposure to abnormal operating conditions, and similar criteria as determined in accordance with the Immersion-Detection Circuit-Interrupter (IDCI) Trip Time Measurement Test, Section 72.4.

Added 71.3.9 effective April 23, 2004

71.3.10 A metal sensor shall:

a) Comply with Internal Wiring, Section 15, and

b) Not be fabricated of iron or steel.

Exception: Stainless steel or other corrosion resistant alloys may be used.

Added 71.3.10 effective April 23, 2004

72 Performance

72.1 Stability test – all types

72.1.1 In addition to the stability tests conducted in 35.1 – 35.3, a hydromassage unit that is intended to be mounted on a tub shall not fall as a result of the following conditions:

a) The hydromassage unit is to be mounted on a tub, its securing means loosened and the unit oriented in the most unfavorable position permitted by its configuration. While in this condition, the motor of the unit is to be started and permitted to run for not more than five minutes.

b) The hydromassage unit is to be mounted on the edge of a 1 inch (25.4 mm) thick plywood board, and a 50 lbf (222 N) is to be applied for 1 minute to any part of the top of the unit. The force is to be applied by means of a 1/2 inch (12.7 mm) diameter rod, the end of which is rounded to a 1/2 inch hemisphere.

72.2 Siphoning and back flow test – air blower type

72.2.1 A hydromassage unit of the air blower type is to be placed on the floor or in any position recommended by the manufacturer (See User Instructions, Section 68), and operated for 5 cycles, each cycle consisting of a minimum of 15 seconds on and 15 seconds off, under all of the following conditions:

a) Hoses and any other parts that are capable of being displaced so as to contact the water are to be placed in a tub that is filled with a saline solution consisting of 1/2 gram of common table salt per liter of distilled water,

b) Any check valve that is provided as part of the unit is to be rendered inoperative, and

c) Any control knob that can be removed without the use of a tool is to be removed.

Upon completion of the fifth cycle, the hoses and any other parts that were in contact with the saline solution are to be removed from the solution and held above the pump. Immediately following, and while still wet from this procedure, the unit is to meet the requirements for Leakage Current (Section 43) and Dielectric Voltage-Withstand (Section 48) Tests.

72.3 Exposure to water test

72.3.1 The leakage current from a hydromassage unit shall not exceed 5 mA at any time during the 1 hour that it is continuously being monitored while immersed in water having a resistivity of 200 or 20,000 ohm-centimeters – whichever resistance provides the more adverse condition for the product tested – and energized under the conditions outlined in 72.3.2 – 72.3.4.

Exception No. 1: A hydromassage unit that employs a GFCI or other type circuit interrupter need not comply with the 5 mA limit, when it has been tested and shown that the device interrupts the supply circuit in compliance with the ″time vs. current″ requirements for Class A units (GFCI) outlined in the Standard for Ground-Fault Circuit-Interrupters, UL 943, when measured with respect to the conductive metal tub.

Exception No. 2: A cord connected hydromassage unit that is to be installed over the side of a tub such that the electrical parts are located in the section outside of and along the outer wall of the tub is not subject to this requirement.

72.3.2 With any combination of the hydromassage unit's operating switches in the ″on″ position, the unit is to be placed in a tub having a metal conductive surface and filled with water (200 or 20,000 ohm-centimeters resistivity) to a depth that permits the unit to be completely submerged below the surface of the water while lying in contact with the bottom of the tub. The power supply cord is to be immersed in the water so that 12 inches, measured from the face of the plug, protrudes from the surface of the water. The test is to be conducted with the hydromassage unit oriented in any position permitted by its configuration.

72.3.3 With the hydromassage unit energized from a supply circuit as described in 41.2, the leakage current on the metal tub is to be continuously monitored through a 500 ohm non-inductive resistor in parallel with an 0.45 microfarad capacitor connected between the grounded side of the power supply circuit and the conductive metal tub. Using a new unit, the measurement is to be repeated with the polarity of the supply circuit reversed.

72.3.4 When the test conducted as described in 72.3.1, 72.3.2, and 72.3.3 – i.e., any combination of operating switches in the ″on″ position – is not representative of the test with the switches in the ″off″ position, the test is to be repeated using new units with the switches in the ″off″ position.

72.4 Immersion-Detection Circuit-Interrupter (IDCI) Trip Time Measurement Test

Added 72.4 effective April 23, 2004

72.4.1 As-received hydromassage units

Added 72.4.1 effective April 23, 2004

72.4.1.1 Samples of hydromassage units that are provided with an IDCI shall be subjected to the tests described in 72.4.1.2 – 72.4.1.7. The results are acceptable if the IDCI trips, causing the flow of current to ground to cease within the time interval, T, when the current to ground, I, is within the range of 6 – 264 milliamperes, in accordance with the relationship:

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

in which:

T is the interval in seconds and

I is the current to ground in milliamperes rms.

Added 72.4.1.1 effective April 23, 2004

72.4.1.2 Three samples are to be tested individually while connected to their rated source of supply as described in 72.4.1.3, and then connected to a voltage equal to 85 percent of the rated voltage. The tests are to be conducted with the hydromassage unit samples in various configurations (including the orientation that results in the most unfavorable condition of use) with the:

a) Switch in the off position,

b) Switch in the on position, and

c) Heat/speed switches in the most disadvantageous settings.

d) Tubes, matts, and other accessories in the most disadvantageous positions.

e) Appliance plug inserted in one position into the supply-circuit receptacle and then with the polarity reversed.

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

Added 72.4.1.2 effective April 23, 2004

72.4.1.3 The voltage applied to an integrally connected motor is to be 120 volts for an appliance rated at 110 – 120 volts, 240 volts for an appliance rated at 220 – 240 volts, or the rated voltage of the appliance for other cases.

Added 72.4.1.3 effective April 23, 2004

72.4.1.4 Each sample is to be placed at the bottom of an empty, isolated, conductive metal tub of a convenient size. The tub is to be equipped such that it can be filled from beneath at a rate of no greater than 5 inches (127 mm) of water per hour. The tub is to be connected to earth ground through a noninductive 500-ohm resistor. As the tub is filled, the leakage current is to be continually measured and a trace of the current flow as a function of time is to be obtained. The water flow is to be stopped when the leakage current reaches 6 milliamperes or the IDCI functions, whichever occurs first. One minute after the IDCI has tripped and without changing any of the test conditions, a user-resettable IDCI is to be reset and the current value and tripping time measurements are to be repeated. The results are acceptable if in each immersion the IDCI trips at a current:

a) Less than 6 milliamperes or

b) Greater than 6 milliamperes in a period of time to comply with the time and current relationship specified in 72.4.1.1. The period of time is to be measured from the moment the current flow exceeds 6 milliamperes to the moment the current ceases to flow. When the IDCI trips, the flow of current to ground is to cease.

Added 72.4.1.4 effective April 23, 2004

72.4.1.5 The isolated tub described in 72.4.1.4 is to be filled with 12 inches (305 mm) of water. Three samples are to be placed in the water such that different surfaces of the samples strike the water first. The leakage current is to be continuously measured and a trace of the current flow as a function of time is to be obtained.

Added 72.4.1.5 effective April 23, 2004

72.4.1.6 The tests described in 72.4.1.2 – 72.4.1.5 are to be conducted two separate times using water with a resistivity of 200 ohm-cm and 20,000 ohm-cm as described in 72.4.1.8.

Added 72.4.1.6 effective April 23, 2004

72.4.1.7 A typical test arrangement for the test described in 72.4.1.4 is shown in Figure 72.1. In the arrangement, the pump is connected to a source of supply of variable voltage so that the water flow rate may be regulated. The tubing that connects the holding tank to the pump and the pump to the conductive tank is nonmetallic flexible tubing (such as aquarium air hose) and is of such length that it extends to the bottom of the conductive tub so that the water fills the tub from below.

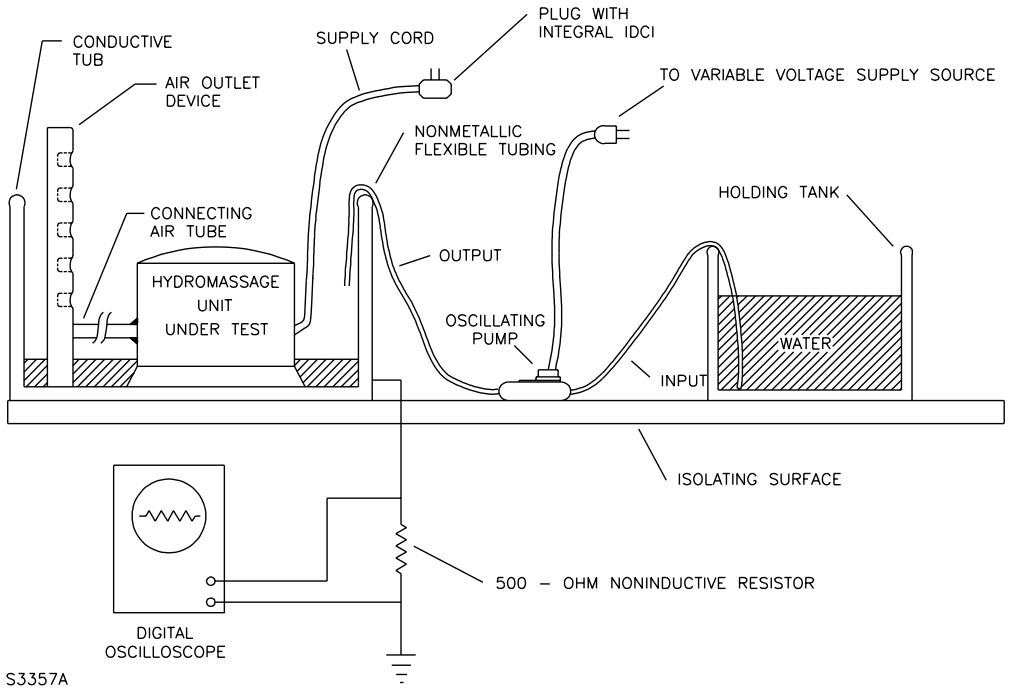
Added 72.4.1.7 effective April 23, 2004

72.4.1.8 The water resistivities specified in 72.4.1.6 are to be obtained by the addition of sodium chloride (common table salt) to distilled water or tap water. The water temperature is to be 20 – 40°C (68 – 104°F).

Added 72.4.1.8 effective April 23, 2004

Figure 72.1
IDCI trip test arrangement

Added Figure 72.1 effective April 23, 2004



72.4.2 Conditioned hydromassage units

Added 72.4.2 effective April 23, 2004

72.4.2.1 The requirements specified in 72.4.1.2 – 72.4.1.8 are to be applied to samples of a hydromassage unit provided with an IDCI that have been subjected to one of the following tests (each test is to be conducted):

a) Reservoir overflow test, Section 53;

b) Dispenser leakage test, Section 54; and

c) Cleaning, Section 55.

Added 72.4.2.1 effective April 23, 2004

72.4.2.2 The tests on the conditioned samples are to be conducted using the on-off switch position, the supply circuit voltage, the water resistivity, and the like as specified in 72.4.1.2, 72.4.1.3, and 72.4.1.6, that resulted in the highest leakage current and longest IDCI trip time determined in accordance with 72.4.1.4. The results are acceptable if the IDCI trips at a current:

a) Less than 6 milliamperes or

b) Greater than 6 milliamperes in a period of time to comply with the time and current relationship specified in 72.4.1.1. The period of time is to be measured from the moment the current flow exceeds 6 milliamperes to the moment the current ceases to flow. When the IDCI trips, the flow of current to ground is to cease.

Added 72.4.2.2 effective April 23, 2004

72.5 Dew Point Humidity Test

Added 72.5 effective April 23, 2004

72.5.1 Three samples of a hydromassage unit provided with an IDCI are to be conditioned in a chamber at a temperature of 5 ±2°C (41 ±3.6°F) for at least 4 hours and then transferred to a humidity chamber having a relative humidity of 86 ±2 percent at a temperature of 32 ±2°C (89.6 ±3.6°F). The transfer time is not to exceed 1 minute. The samples are to be energized by the insertion of their attachment plugs into receptacles of the voltage specified in 72.4.1.3. The on-off switch of the hydromassage is to be in the off position. The samples are to remain in the humidity chamber for 15 minutes. The results are acceptable if the IDCIs do not trip while in the chamber.

Added 72.5.1 effective April 23, 2004

72.6 Conductive Coating Test

Added 72.6 effective April 23, 2004

72.6.1 General

Added 72.6.1 effective April 23, 2004

72.6.1.1 A hydromassage unit that is provided with a conductive coating for use as an IDCI sensor shall be conditioned as described in 72.6.2.1 – 72.6.5.1 and then subjected to the mechanical endurance test described in 72.6.1.2. Five separate samples are to be used for each conditioning. The resistance from at least three points on the interior of the enclosures (typically a point near the exhaust opening, a point near the intake opening, and a point that is the longest distance away from the point of connection of the sensor wire) to the sensor wire termination is to be determined before the conditioning begins, after conditioning, and then again after the mechanical endurance test.

Added 72.6.1.1 effective April 23, 2004

72.6.1.2 After conditioning, all samples are to be subjected to 150 cycles of mechanical endurance or the number of cycles less than 150 that results in the hydromassage unit becoming inoperable due to breakage of an electrical connection or component or a mechanical breakdown. Detachment of the exhaust grille or intake grille, or similar failure of mechanical parts that do not result in the hydromassage unit becoming inoperable shall not be considered to be the end of the test. It is usually necessary to examine and energize the samples after each impact to determine if the hydromassage unit has become inoperable. The samples shall be subjected to the Resistance to Impact Test in Section 24 of UL 746C, the Standard for Polymeric Materials - Use in Electrical Equipment Evaluations. The resistance of each sample is then to be determined again between the same points previously used and compared to the first three values of resistance. The results are acceptable if:

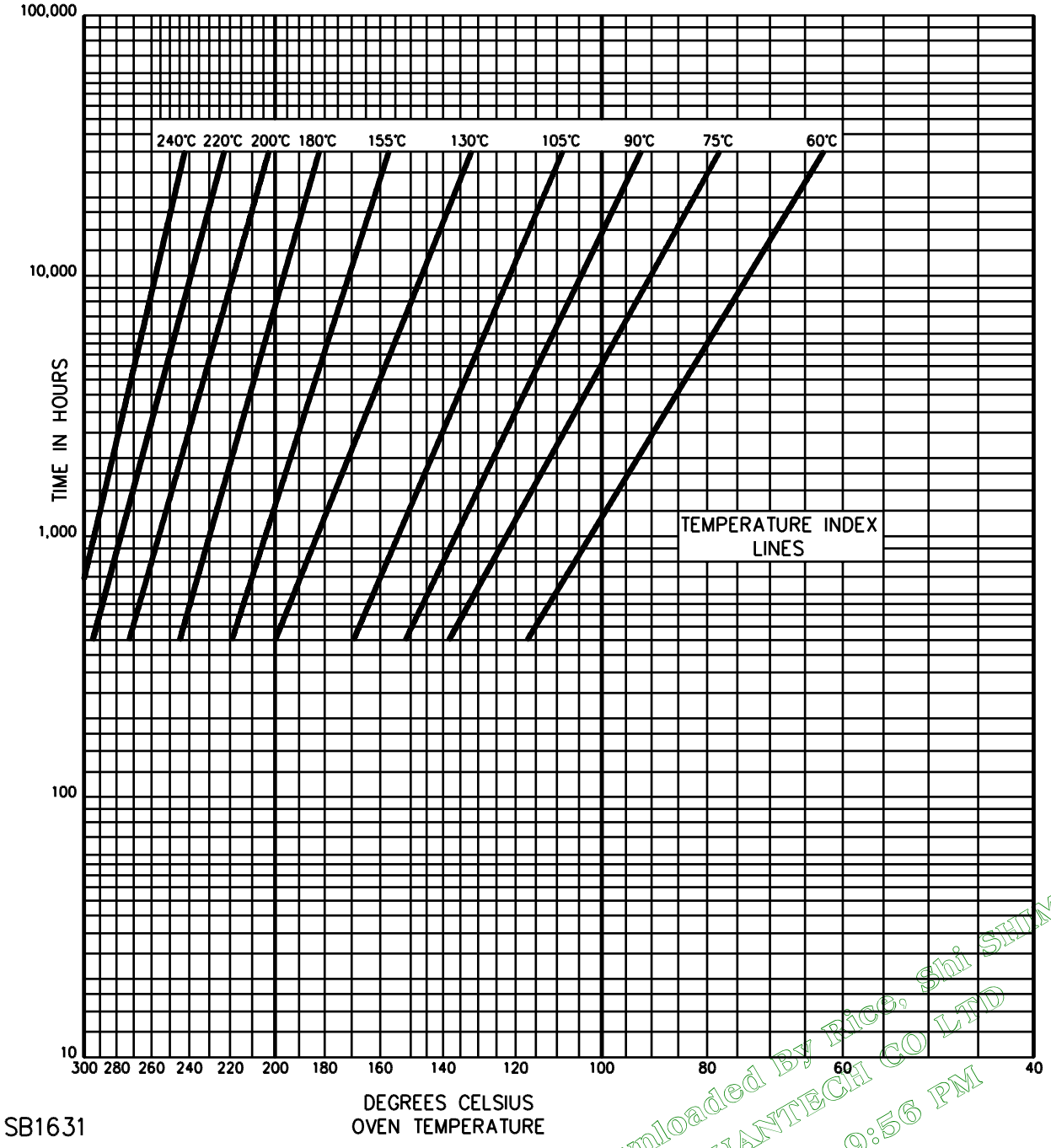
a) The resistance of the samples does not increase to a value in excess of 50 percent of that determined to be the maximum value that will cause the IDCI to trip (The maximum resistance resulting in the threshold trip current flow for the IDCI is usually determined in a separate investigation of IDCIs) and

b) There is no visible cracking, flaking, peeling, wrinkling, blistering, or similar deterioration of the conductive coating.

Added 72.6.1.2 effective April 23, 2004

Figure 72.2
Conditioning time versus oven temperature for temperature index of conductive coatings

Added Figure 72.2 effective April 23, 2004



72.6.2 Thermal cycling

Added 72.6.2 effective April 23, 2004

72.6.2.1 Five samples are to be conditioned for:

a) One hour at 18.0 – 20.0°C (32.4 – 36.0°F) higher than the maximum measured normal-use temperature of the coating determined in accordance with Section 47, but no less than 85°C (185°F) in any case, followed by

b) One hour at 23.0 ±2.0°C (73.4 ±3.6°F) and a relative humidity of 50 ±5 percent, followed by

c) One hour at minus 29.0 ±2.0°C (minus 20.2 ±3.6°F), followed by

d) One hour at 23.0 ±2.0°C (73.4 ±3.6°F) and a relative humidity of 50 ±5 percent, followed by

e) The steps outlined in (a) – (d) repeated two more times.

Added 72.6.2.1 effective April 23, 2004

72.6.3 Limited thermal aging

Added 72.6.3 effective April 23, 2004

72.6.3.1 Five samples are to be conditioned for 300 hours at the oven temperature determined from the respective temperature index line in Figure 72.2, in which the temperature index T is the measured normal operating temperature of the coating determined in accordance with Section 47, but no less than 60°C (140°F). If agreeable to all concerned, a longer time at a correspondingly lower temperature may be used as determined in accordance with Figure 72.2. After the conditioning, the samples are to be brought to and tested at a room ambient temperature of 23.0 ±2.0°C (73.4 ±3.6°F).

Added 72.6.3.1 effective April 23, 2004

72.6.4 Short term aging

Added 72.6.4 effective April 23, 2004

72.6.4.1 Five samples are to be conditioned for 56 days at 18.0 – 20.0°C (32.4 – 36.0°F) higher than the maximum measured normal use temperature of the coating determined in accordance with Section 47, but no less than 85°C (185°F) in any case.

Added 72.6.4.1 effective April 23, 2004

72.6.5 Humidity conditioning

Added 72.6.5 effective April 23, 2004

72.6.5.1 Five samples are to be conditioned for 56 days at 35.0 ±2.0°C (95.0 ±3.6°F) and a relative humidity of 90 ±5 percent.

Added 72.6.5.1 effective April 23, 2004

73 Marking and Instructions

Revised Section 73 heading effective April 23, 2004

73.1 A double insulated hydromassage unit shall be plainly and permanently marked with the words ″Double Insulation – When servicing, use only identical parts.″ The words ″Double-Insulated″ may be used instead of ″Double Insulation″ in the marking.

73.2 Deleted effective April 23, 2004

73.3 The surface of a plug that contains an IDCI, a GFCI, or a similar protective device shall be marked with the word ″WARNING″ and the following or the equivalent: ″To reduce the risk of electric shock, do not remove, modify, or immerse this plug.″ The height of the letters in the word ″WARNING″ shall not be less than 1/8 inch (3.2 mm) and the height of the remaining letters shall not be less than 1/16 inch (1.6 mm).

Added 73.3 effective April 23, 2004

73.4 For an appliance provided with an IDCI, a GFCI, or a similar protective device, the following or equivalent instructions shall be provided: ″This appliance is provided with a protective device that may make the appliance inoperable under some abnormal conditions (such as immersion of the appliance). If the appliance becomes inoperable, return the appliance to a service center for examination and repair.″ For appliances provided with user-resettable protective devices, the instructions shall:

a) Describe the purpose of the test and reset buttons,

b) Specify the frequency of the testing,

c) Describe the indication of proper functioning of the protective device, and

d) Indicate that an appliance that does not operate in the proper functioning condition is to be discarded or returned to a service center for examination and repair.

Exception: For an appliance provided with a user-resettable protective device provided with a reset feature not providing a test function, the instructions shall alert the user to the reset feature and how and when to use it, and shall alert the user to not reset and reuse the appliance should the protective device trip as a result of immersion.

Added 73.4 effective April 23, 2004

73.5 A cord-connected hydromassage unit shall have legible instructions warning the user not to connect the unit with an electrical extension cord of any type. This shall be both in the user manual and on the product and shall include the following wording or the equivalent: ″WARNING: DO NOT USE WITH ANY EXTENSION CORD. THIS WILL DEFEAT THE CIRCUIT PROTECTOR.″ The height of the letters in the word WARNING shall not be less than 1/8 inch (3.2 mm) and the height of the remaining letters shall not be less than 1/16 inch (1.6 mm).

Added 73.5 effective April 23, 2004

73.6 The product markings required in this section shall be located on the unit or a permanent type flag label attached to the power-supply cord.

Added 73.6 effective April 23, 2004

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APPENDIX A

Standards for Components

Standards under which components of the products covered by this standard are evaluated include, but are not limited to, the following:

Title of Standard − UL Standard Designation

Boxes, Metallic Outlet – UL 514A
Circuit Breakers Enclosures, Molded Case Circuit Breakers, Molded Case Switches – UL 489
Circuit Interrupters, Ground-Fault – UL 943
Conduit, Tubing, and Cable Fittings – UL 514B
Controls, Limit – UL 353
Cord Reels – UL 355
Cord Sets and Power-Supply Cords – UL 817
Double Insulation Systems for Use in Electrical Equipment– UL 1097
Fuseholders – UL 512
Heating Elements, Sheathed – UL 1030
Lampholders, Edison-Base – UL 496
Marking and Labeling Systems – UL 969
Motors, Electric – UL 1004
Motors, Overheating Protection for – UL 2111
Plastic Materials for Parts in Devices and Appliances, Tests for Flammability of – UL 94
Plugs and Receptacles, Attachment – UL 498
Polymeric Materials – Use in Electrical Equipment Evaluations – UL 746C
Power Units, Class 2 – UL 1310
Printed-Wiring Boards– UL 796
Protectors, for Use in Electrical Equipment, Supplementary– UL 1077
Safety-Related Controls Employing Solid State Devices, Tests for – UL 991
Sharpness of Edges on Equipment, Test for – UL 1439
Switches, General-Use – UL 20
Switches, Special-Use – UL 1054
Tape, Polyvinyl Chloride, Polyethylene, and Rubber Insulating – UL 510
Temperature-Indicating and -Regulating Equipment – UL 873
Thermal-Links – Requirements and Application Guide – UL 60691
Wires and Cables, Rubber-Insulated – UL 44
Wires and Cables, Thermoplastic-Insulated – UL 83

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