

UL 499

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Electric Heating Appliances

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Electric Heating Appliances, UL 499

Twelfth Edition, Dated March 26, 1997

Revisions: This Standard contains revisions through and including February 13, 2004.

Summary of Topics

These revision to ANSI/UL 499 are being issued to reflect changes in the 2002 edition of the National Electrical Code (NEC), ANSI/NFPA 70.

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 new requirements are substantially in accordance with UL's Bulletin(s) on this subject dated March 20, 2003, October 24, 2003 and December 9, 2003. The bulletin(s) is now obsolete and may be discarded.

The revisions dated February 13, 2004 include a reprinted title page (page1) for this Standard.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

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

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This ANSI/UL Standard for Safety, which consists of the Twelfth edition is under continuous maintenance, whereby each revision is ANSI approved upon publication. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Written comments are to be sent to UL-RTP Standard Department, 12 Laboratory Dr., P.O. Box 13995, Research Triangle Park, NC, 27709-3995.

The Department of Defense (DoD) has adopted UL UL 499 on August 17, 1987. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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.

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover heating appliances rated at 600 V or less for use in unclassified locations in accordance with the National Electrical Code (NEC), ANSI/NFPA 70.

1.1 revised February 13, 2004

1.2 These requirements do not cover electric heating equipment or appliances that are covered by individual requirements that are separate from this Standard.

1.3 For the purposes of this Standard, a heating appliance is defined as an electrically energized product that directly or indirectly generates heat to perform its intended function.

1.4 These requirements also cover electrically energized products that generate steam for other than space heating purposes and have an electrical power rating of 15 kW or less per steam generating vessel.

1.5 Steam generating products of the type described in 1.4 having an electrical input power rating of more than 15 kW per steam generating vessel are to be evaluated by the requirements in the Standard for Heating, Water Supply, and Power Boilers – Electric, UL 834.

1.6 Each steam generating vessel in a multi-vessel unit shall comply with these requirements. The unit shall also be provided with the marking in 45.37.

1.6 relocated from 4.2 March 26, 1997

1.7 Deleted November 14, 2002

2 Components

2.1 Except as indicated in 2.2, 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.

2.2 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.

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

2.4 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 Units of Measurement

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

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

4 References

4.1 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.

CONSTRUCTION

5 General

5.1 A heating appliance intended for use in a hazardous location is judged on the basis of its compliance with the requirements in this Standard, and further appropriate examination and tests to determine whether it is acceptable for the purpose.

5.2 Only materials that are acceptable for the particular use shall be used in a heating appliance. A heating appliance shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

5.3 If the operation of a heating appliance involves the generation and confining under pressure of steam or other gas, consideration is to be given to the possibility of risk of explosion incident to such operation. This applies in the case of a product having immersed electrodes, where the electrolysis of water may result in the accumulation of oxygen and hydrogen. The product is not acceptable unless its strength has been investigated with respect to any risk of explosion that may be involved.

6 Frame and Enclosure

6.1 The frame and enclosure of a heating appliance shall be strong and rigid to resist the abuses to be encountered during intended use. The degree of resistance inherent in the product shall preclude total and partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other defects which alone or in combination constitute an increase in the risk of fire, electric shock, or injury to persons.

6.2 A vaporizer water reservoir of glass or similar material that might, upon breaking, cause skin lacerations shall be resistant to thermal-shock and impact.

6.3 A heating appliance shall be provided with an enclosure of material acceptable for the application, that shall house all electrical parts, except a supply cord and a recessed open-wire-element unit as mentioned in 13.3, that may result in risk of electric shock or injury to persons under any condition of use. If a heater is for permanent installation (intended for permanent connection to the power supply), the enclosure shall be provided with means for mounting in the intended manner and shall be furnished with any necessary fittings, such as brackets, hangers, or the like.

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

6.5 Among the factors when an enclosure is being considered for acceptability, are its:

- a) Physical strength,
- b) Resistance to impact,
- c) Moisture-absorptive properties,
- d) Combustibility,
- e) Resistance to corrosion, and
- f) Resistance to distortion at temperatures to which the enclosure may be subjected under conditions of use.

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

6.6 Cast- and sheet-metal portions of the enclosure shall be no thinner than indicated in Table 6.1 unless the enclosure complies with 6.5 and 6.7.

6.7 In addition to the factors in 6.5, an enclosure of sheet metal is to be considered with respect to its size and shape, the thickness of metal and the intended use of the product.

6.8 Electrical parts of a heating appliance, including open-wire elements, shall be so located or enclosed that protection against unintentional contact with uninsulated live parts will be provided (see also 23.6). Insulated motor brush caps do not require additional enclosure.

6.9 The enclosure shall be such that molten metal, burning insulation, flaming particles, or the like, is not likely to fall on combustible materials, including the surface upon which the enclosure is supported.

Table 6.1
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	(mm)	inches	(mm)	inches	(mm)
Die-cast	3/64	(1.2)	–	–	5/64	(2.0)
Cast malleable iron	1/16	(1.6)	–	–	3/32	(2.4)
Other cast metal	3/32	(2.4)	–	–	1/8	(3.2)
Uncoated sheet steel	0.026 ^a	(0.66) ^a	0.032	(0.81)	0.026	(0.66)
Galvanized sheet steel	0.029 ^a	(0.74) ^a	0.034	(0.86)	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 judged under considerations such as those mentioned in 6.5.

6.10 The requirement in 6.9 necessitates use of a barrier of metal, phenolic, urea, ceramic or similar material:

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) Open main winding,

ii) Open starting winding, and

iii) Starting switch short-circuited, or

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

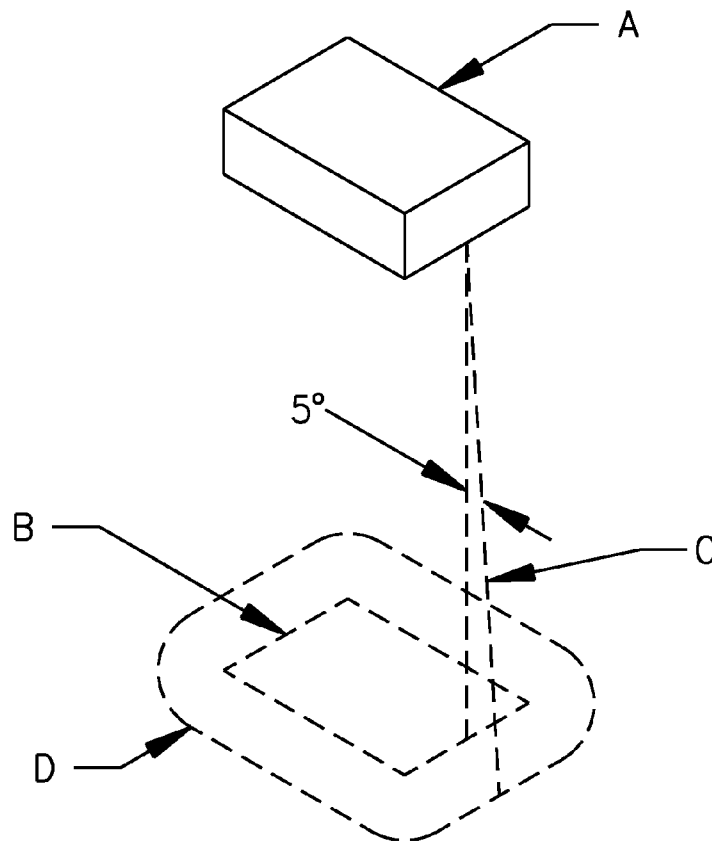
4) The motor complies with the requirements for impedance-protected motors.

b) Under wiring, unless it complies with the VW-1 (Vertical-Specimen) Flame Test described in Section 1080 of the Reference Standard for Electrical Wires, Cables, and Flexible Cords, UL 1581.

6.11 The requirement in 6.9 also necessitates that a switch, transformer, relay, solenoid, or the like, be individually and completely enclosed except at terminals, unless it can be shown that malfunction of the component is not likely to result in a fire, or unless there are no openings in the bottom of the enclosure. An opening in the bottom of the enclosure is not acceptable if it is located directly below field- or factory-made splices or overload or overcurrent protective devices.

6.12 The barrier mentioned in 6.10 shall be horizontal, shall be located as indicated in Figure 6.1, and shall not have an area less than that described in that illustration. Openings for drainage, ventilation, and the like, may be employed provided molten metal, burning insulation, or the like, is not likely to fall through the opening onto combustible material.

Figure 6.1
Location and extent of barrier



SA0604-1

NOTES -

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

B - Projection of outline of component on horizontal plane.

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

- 1) tangent to the component,
- 2) 5 degrees from the vertical, and
- 3) so oriented that the area traced out on a horizontal plane is maximum.

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

6.13 The criteria for judging a heating appliance enclosure, other than as described in 6.8, are given in 6.15 and 6.16 and in the following items and related illustrations:

a) An opening in the enclosure is acceptable if the probe (illustrated in Figure 6.2), when inserted into the opening, cannot be made to touch any uninsulated live part of film-coated wire that involves a risk of electric shock. The probe is to be applied to any depth that the opening will permit; and shall be rotated and articulated in all possible configurations before, during and after insertion.

b) An opening that will not prevent entrance of the probe as mentioned in (a) is acceptable under the conditions described in Figure 6.3.

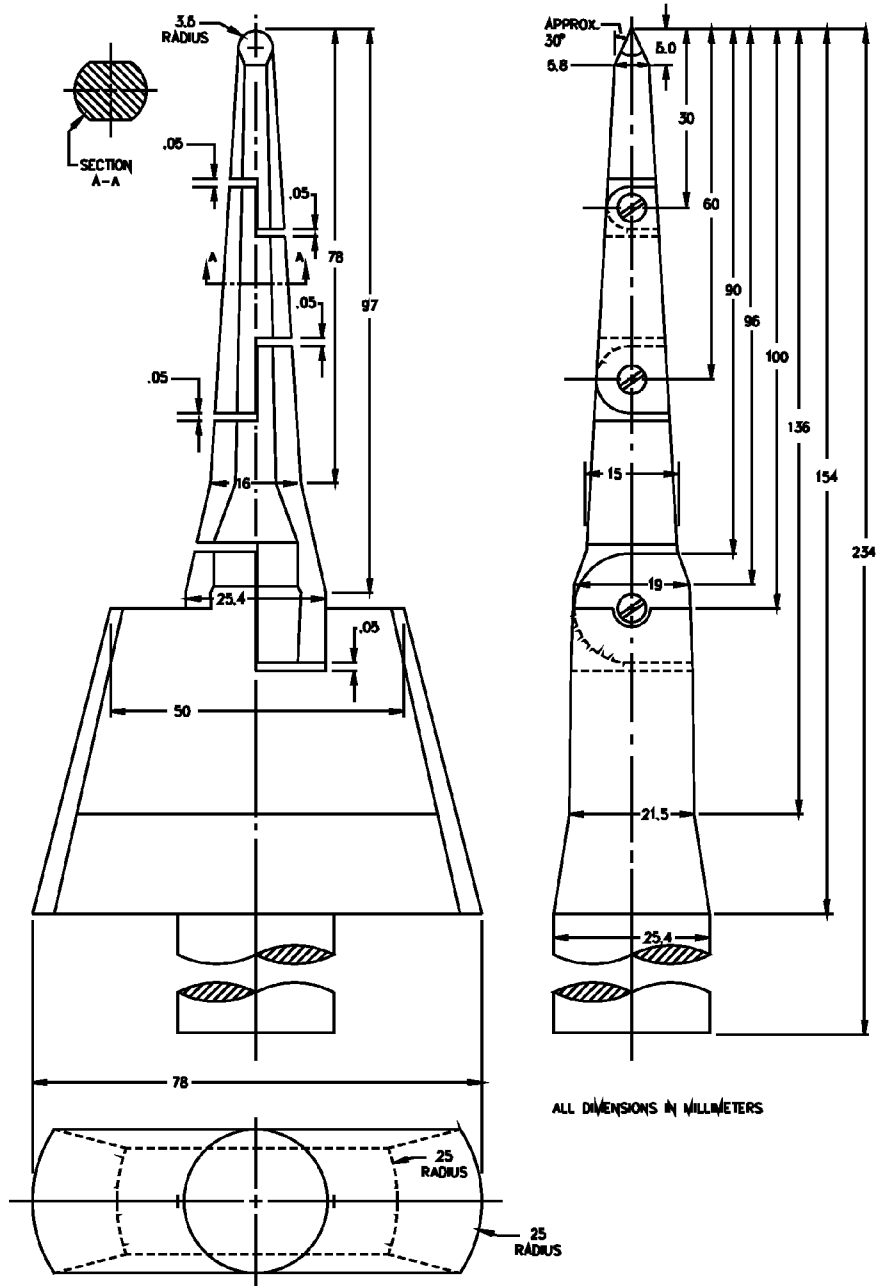
6.14 The opening illustrated in Figure 6.3 is acceptable if, within the enclosure, there is no uninsulated live part or enamel-insulated wire less than X distance from the perimeter of the opening, as well as within the volume generated by projecting the perimeter X distance perpendicular to its plane. X equals five times the diameter of the largest diameter rod which can be inserted through the opening, but not less than 4 inches (102 mm). In evaluating an opening, any barrier located within the volume usually is ignored unless it intersects the boundaries of the volume in a continuous, closed line.

6.15 Although meeting the requirements in 6.13, an opening is unacceptable:

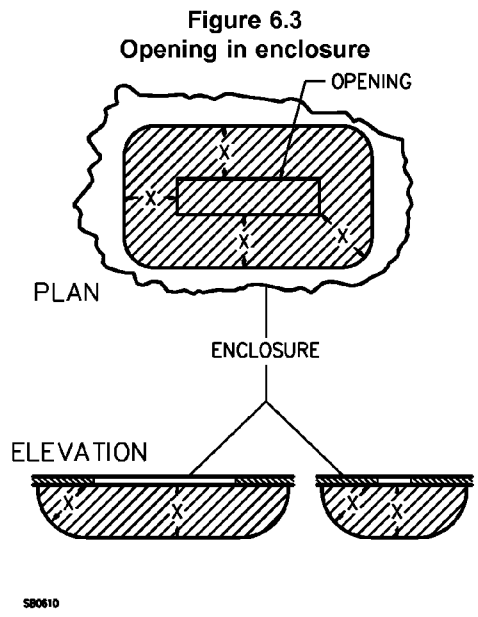
a) Anywhere in the enclosure of a hand-supported product or

b) In any portion of a product hand-held during use if a probe as illustrated in Figure 6.4, when inserted point first a maximum distance of 2 inches (50.8 mm) into the opening touches any uninsulated live part or touches any enamel-insulated wire.

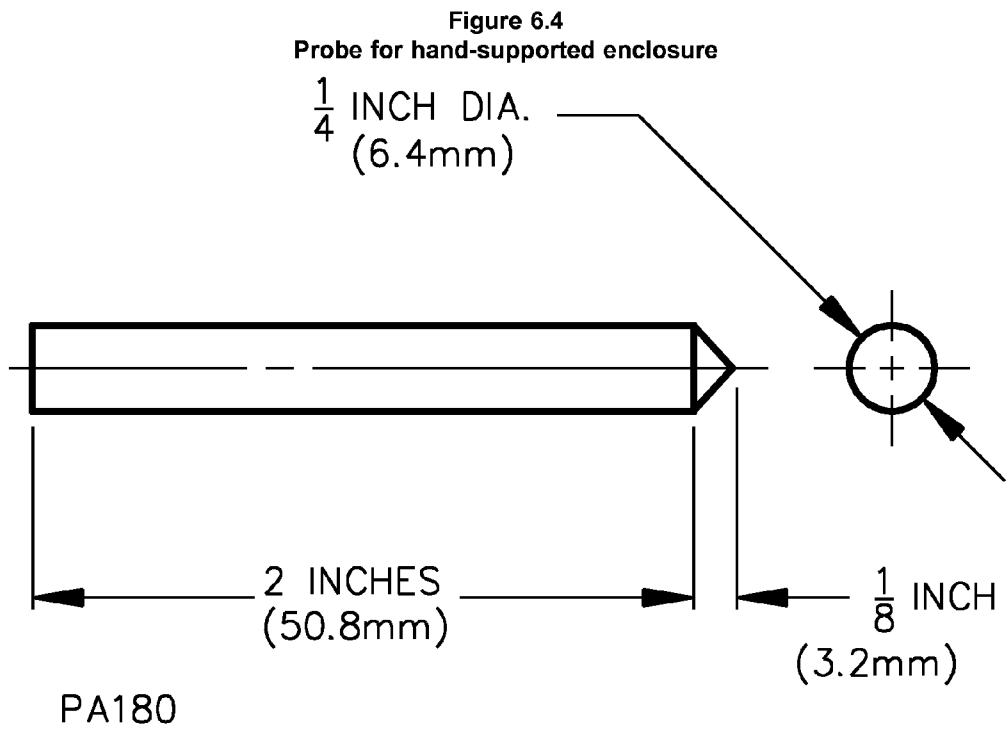
Figure 6.2
Articulate probe with web stop



PA100A



proportions exaggerated for clarity



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

6.17 During the examination of a heating appliance in connection with the requirements in 6.8 – 6.13, a part of the outer enclosure that may be removed without the use of tools by the user of the product (for the attachment of accessories, for access to means for making operating adjustments, or for other reasons) is to be disregarded – that is, it is not to be assumed that the part in question affords protection against risk of electric shock. A warning marking, such as that specified in 45.6 is not considered to eliminate this risk of electric shock.

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

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

- a) The degree of exposure,
- b) The sharpness of the moving parts,
- c) The likelihood of unintentional contact with the moving parts,
- d) The speed of movement of those parts, and
- e) The likelihood of fingers, arms, or clothing being drawn into the moving parts – such as at points where gears mesh, where belts travel onto a pulley or where moving parts close in a pinching or shearing action.

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

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

6.22 A component of a heating appliance that is likely to need inspection, replacement, cleaning, or other servicing shall be as accessible as possible. Except as noted in 6.23, the component shall be readily accessible without the use of special tools – tools not available to other than service personnel – if it is intended to be manually operated or adjusted or periodically serviced.

6.23 If a product is intended primarily for use in public places, such as gas stations, theaters, bus terminals, or the like:

- a) The construction may be such that special tools are required to gain access to components that are likely to need inspection, replacement, cleaning, adjustment, or other servicing.
- b) A door or cover giving access to an overload protective device need not be provided with a hinge, latch, or equivalent if the cover intended must be in place to perform its function.

6.24 The bulb and capillary tube of a thermostat shall be protected from physical damage if such damage of the tube or bulb may result in a risk of fire.

6.25 The mounting means of a wall-mounted insecticide vaporizer shall be such that:

- a) The product will be secured against tipping or dislodgement as a result of unintentional contact with the body of the product itself or with the power-supply cord, and
- b) The removal of the vaporizer can be accomplished readily, if it is necessary that the vaporizer be removed from its mounting for cleaning, refilling, or other servicing.

6.26 With reference to the requirement in 6.25, a simple keyhole slot or hanger ring is not acceptable as a mounting means unless other provisions are made, such that spillage of the insecticide will not result from tipping or dislodgement of the product.

6.27 If the enclosure of an insecticide vaporizer for wall mounting is of porcelain, glass, or other similarly brittle material, it shall not break or crack to the extent that uninsulated live parts will be exposed to contact, when dropped on a hardwood surface. The height through which the product is to be dropped is to be 8 ft (2.44 m) for a commercial-type vaporizer, and 6 ft (1.83 m) for a household product.

6.28 The sheath employed to enclose the heating element of an immersion-type heater for use with fuel oil shall be of steel, stainless steel, or other metal resistant to corrosion in fuel oil; brass, bronze, or copper is not considered acceptable for this application. The sheath employed to enclose the heating element of an immersion-type water heater shall be of a metal resistant to corrosion in water.

6.29 Openings provided in a soldering tool, such as for ventilating purposes, shall be of such size and orientation with respect to the soldering tip that entry of falling or dripping molten solder, or unintentional insertion of solder wire is not likely to contact, bridge, or otherwise reduce the spacings between uninsulated live parts of opposite polarity, or uninsulated live parts and accessible dead metal parts. Consideration shall be given to the orientation of the soldering tool during use.

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

6.31 When determining compliance with 6.30, any part of the enclosure or barriers that can be removed without the use of tools to gain access to the mounting means are to be removed.

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

7 Assembly

7.1 A soldering iron, or other cord-connected heating appliance that is likely to be laid on combustible material shall be provided with a stand of noncombustible material upon which it may be placed when not in use, unless the temperature attained by the product is not high enough to cause the ignition of the combustible material.

7.2 The stand may be a separate device or attached to the product, except that an integral type of stand is required for a charcoal ignitor.

7.3 A switch, lampholder, attachment-plug receptacle, or plug-type connector provided as a part of a heating appliance shall be secured so that it is not likely to turn.

7.4 Uninsulated live parts shall be so secured to the base or surface that they are not likely to turn or shift in position as the result of stresses if such motion results in a reduction of spacings below the minimum required in 25.1.1.1 – 25.1.1.4.

7.5 Friction between surfaces is not acceptable as a means to keep live parts or components from shifting or turning. A lock washer, properly applied, is acceptable for this purpose.

8 Stability

8.1 The stability of a heating appliance shall be such that it will not be overturned readily during use.

8.2 A portable household heating appliance in which liquid is heated to a temperature greater than 115°F (46°C) is to be placed on a plane inclined at an angle of 15 degrees to the horizontal. The product is to be positioned and loaded with whatever combination of separable components, liquid, or other media (material) that results in the maximum tendency to overturn under conditions of intended use. The product is to contain at least 5 oz (148 mL) of liquid. The product is to be prevented from sliding on the inclined surface. The product shall not overturn as a result of this test.

8.3 To determine if a vaporizer in which water is heated complies with the requirements of 8.1, the product shall not overturn when subjected to the test described in 8.4.

8.4 The vaporizer is to be placed at any position of use on a plane inclined at an angle of 30 degrees to the horizontal. For this test the product is to be assembled and filled with liquid in any condition simulating operating conditions, so as to result in the maximum tendency to overturn. The product is to be supported so that it does not slide on the inclined plane.

9 Corrosion Protection

9.1 Except as noted in 9.2, iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other means, if the deterioration of such unprotected parts would be likely to result in risk of fire or electric shock.

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

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

10 Supply Connections

10.1 Permanently-connected products

10.1.1 General

10.1.1.1 Except as noted in 10.1.1.2 and 10.2.1.2, a product intended for permanent connection electrically to the power supply shall have provision for connection of one of the wiring systems that in accordance with the National Electrical Code, ANSI/NFPA 70, would be acceptable for the product.

10.1.1.2 An insecticide vaporizer intended for wall mounting may employ a flexible cord for connection to the power supply, provided that the length of the cord is not more than 3 ft (0.9 m) for a commercial product and not more than 6 ft (1.8 m) for a household product.

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

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

10.1.1.5 An electrical component shall not be mounted on a part, such as the cover of a wiring-terminal compartment, that must be removed for the purpose of making or inspecting field-wiring connections.

Exception: A single electrical component, such as a switch, a pilot light, or the like, may be mounted on a wiring compartment cover provided that:

- a) The component connecting leads are of such length to provide for the making, and examination, of field-wiring connections,*
- b) None of the component connections is to be field wired,*
- c) Strain relief is provided to prevent stress from being transmitted to the component wiring terminations, and complies with the strain relief test in 40.2,*
- d) The minimum size of the component leads is 18 AWG (0.82 mm²), and*
- e) Wiring terminations on the component are recessed or protected by barriers of insulating material or the equivalent that will provide protection from contact with wiring installed in the box, or unintentional contact during installation or inspection of field wiring.*

10.1.1.5 revised February 13, 2004

10.1.2 Wiring terminals

10.1.2.1 A heating appliance intended for permanent connection to the power supply shall be provided with wiring terminals or leads for the connection of conductors having an ampacity of not less than 125 percent of the current rating of the 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.

10.1.2.2 For the purpose of these requirements, wiring terminals are considered to be terminals to which power-supply or control connections will be made in the field when the product is installed. It is to be assumed that 60°C (140°F) wire will be used for connections to a continuous-load type of heating appliance rated at 80 A or less and an intermittent-load type of heating appliance rated at 100 A or less. Wire rated for 75°C (167°F) will be assumed to be used with product rated in excess of these values.

10.1.2.3 A wiring terminal shall be provided with a soldering lug or with a pressure wire connector securely fastened in place for example, bolted or held by a screw, except that a wire-binding screw may be employed at a wiring terminal intended to accommodate a 10 AWG (5.3 mm²) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in position.

10.1.2.3 revised February 13, 2004

10.1.2.4 A wiring terminal shall not turn or shift in position. Friction between surfaces is not an acceptable means. An acceptable means may be by the use of two screws or rivets, by square shoulders or mortises, by a dowel pin, lug or offset, by a connecting strap or clip fitted into an adjacent part, or by some other equivalent method.

10.1.2.5 A wire-binding screw at a wiring terminal shall not be smaller than No. 10, except that a No. 8 screw may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm²) or smaller conductor, and a No. 6 screw may be used for the connection of a 16 or 18 AWG (1.3 or 0.82 mm²) control-circuit conductor.

10.1.2.5 revised February 13, 2004

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

10.1.2.7 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned in 10.1.2.1, but not smaller than 14 AWG (2.1 mm²), under the head of the screw or the washer.

10.1.2.7 revised February 13, 2004

10.1.2.8 A wire-binding screw shall thread into metal.

10.1.2.9 A heating appliance intended for connection to a grounded power-supply conductor and employing:

- a) A lampholder or element holder of the Edison-screw-shell type,
- b) A single-pole switch, or

c) A single-pole automatic control

shall have one terminal or lead identified for connection of the grounded conductor of the supply circuit. The identified terminal or lead shall be the one that is connected to screw shells of lampholders or element holders, and with no connection to single-pole switches or single-pole automatic controls, except as noted in 24.2.

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

10.1.2.10 revised February 13, 2004

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

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

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

10.1.2.14 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 by being marked "g", "gr", "gnd", "grounding", or the like, or by a marking on the wiring diagram provided on the heating appliance. The wire-binding screw or pressure-wire connectors shall be so located that it is unlikely to be removed during the servicing of the product.

10.1.2.15 A terminal intended solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size acceptable for the particular product, in accordance with the National Electrical Code, ANSI/NFPA 70.

10.2 Cord connected products

10.2.1 General

10.2.1.1 A cord-connected heating appliance shall be provided with a length of attached flexible cord and an attachment plug for connection to the supply circuit, or shall have male pin terminals that accommodate a detachable power-supply cord. The length of the cord shall be within the limits indicated in Table 10.1. All detachable power-supply cords and permanently-connected power-supply cords shall comply with the requirements of the Standard for Cord Sets and Power-Supply Cords, UL 817.

Table 10.1
Lengths of cord connection

Type of heating appliance	Kind of cord connection	Minimum acceptable length ^a		Maximum acceptable length ^a	
		ft	(m)	ft	(m)
Counter-top, bench-top, or table-top appliances intended for household use	Attached cord or detachable power-supply cord	2.0 ^b	(0.6) ^b	7.0	(2.1)
Soldering iron, guns, wood burning pencils	Attached cord	4.5	(1.4)	—	—
Soldering station	Attached cord or detachable power-supply cord	2.5 ^b	(0.8) ^b	—	—
Stock tank water heater (except floatation type), bucket heater, deicer and similar appliances used out of doors	Attached cord	2.0	(0.6)	6.0	(1.8)
Adhesive guns (hot melt), brooders, incubators, water stills	Attached cord	5.0	(1.5)	—	—
All other heating appliances intended for outdoor use	Attached cord or detachable power-supply cord	1.0 ^c	(0.3) ^c	—	—
All heating appliances not covered above	Attached cord or detachable power-supply cord	6.0	(1.8)	—	—

^a Measured external to the appliance and including the fittings but excluding the blades on the attachment plug.
^b See 45.12 when cord length is less than 4.5 ft (1.4 m).
^c See 45.33 when cord length is less than 6 ft (1.8 m).

10.2.1.2 A cord-connected heating product intended to be fastened in place or located in a dedicated space may be acceptable if provided with a short length of flexible cord and an attachment plug for supply connection. The investigation of such a 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 attachment plug.

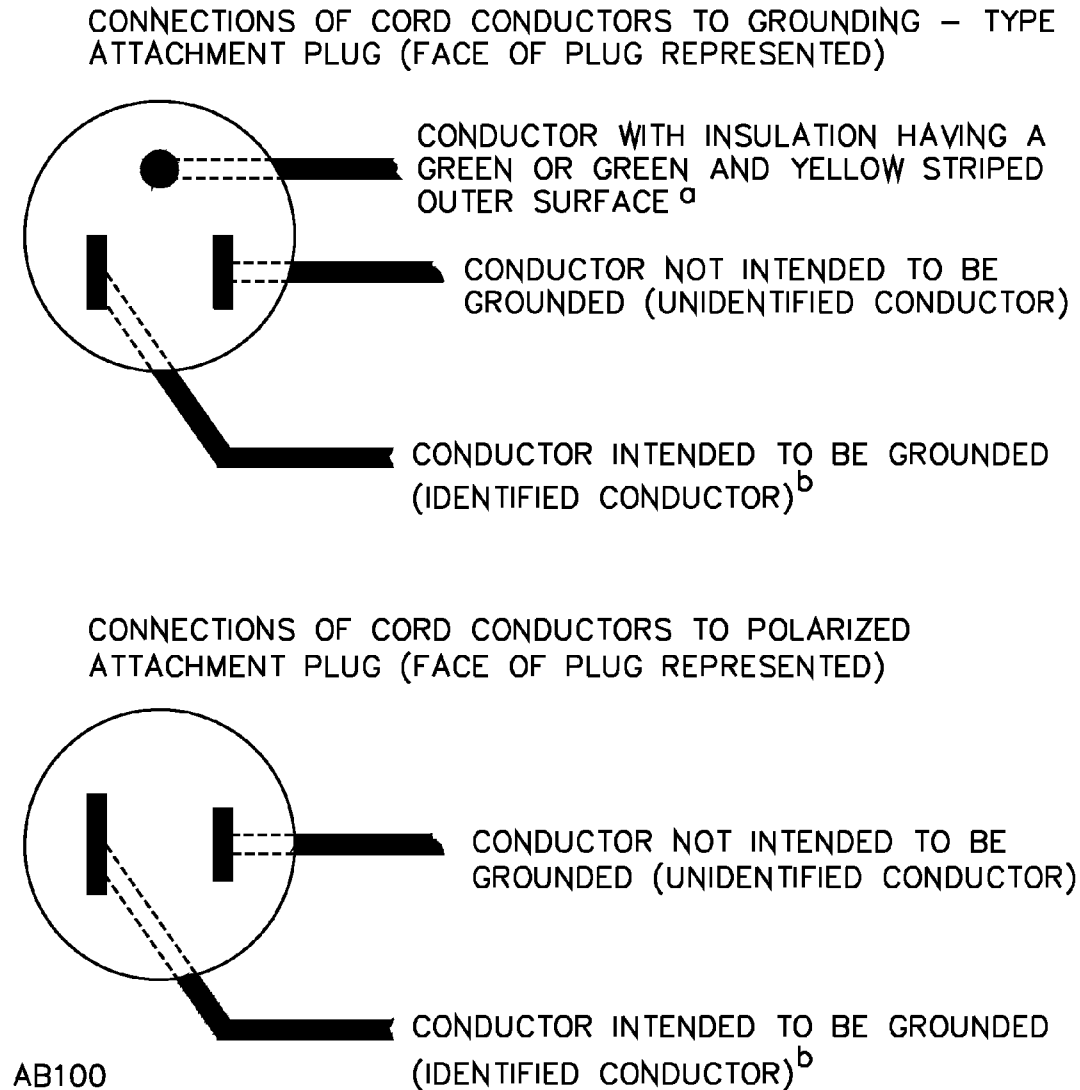
10.2.1.3 For a cord-connected heating appliance, the rating (both current and voltage) of the cord and the fittings, for a product rated at 15 A or less, shall not be less than that of the product. For a product rated at more than 15 A, the ampacity of the cord and fittings shall not be less than the current rating of the product. The current rating of the attachment plug shall not be less than 125 percent of the current rating of the product when the load will constitute a continuous load (3 hours or more), except that a 20-A attachment plug is acceptable for a product rated at no more than 4000 W at 240 V.

10.2.1.4 The attachment plug of the power-supply cord of an appliance provided with a 15- or 20-ampere general-use receptacle shall be of the 3-wire grounding type. The attachment plug of the power-supply cord of an appliance provided with either a manually operated, line-connected, single pole switch for appliance on-off operation or an Edison-base lampholder shall be of the 2-wire polarized or 3-wire grounding type.

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

Figure 10.1
Connection to attachment plugs

Figure 10.1 revised July 17, 1998



NOTES –

- 1) The blade to which the green conductor is connected may have a U-shaped or circular cross section.
- 2) Signifies a conductor identified in accordance with Table 10.2.

Table 10.2
Polarity identification of flexible cords

Table 10.2 revised February 13, 2004

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

^a A wire finished to show a green color with or without one or more yellow stripes or tracers is to be used only as an equipment grounding conductor. See 10.2.1.5 and Figure 10.1.
^b Only for cords – other than Types SP-1, SP-2, and SPT-1– having no braid on any individual conductor.
^c For jacketed cord.
^d Only for Types SP-1, SP-2, SPT-1, and SPT-2 cords.
^e Only for Types SPT-1 and SPT-2 cords.

10.2.1.6 The conductor of the power-supply cord that is intended to be grounded, identified by Table 10.2, shall have the following items connected to it:

- a) The screw shell of an Edison-base lampholder; and
- b) The terminal or lead of a receptacle intended to be grounded.

10.2.1.7 A cord-connected product that is provided with keyhole slots, notches, hanger holes, brackets, or the like, for mounting to a wall shall be considered as not intended to be moved.

10.2.1.8 If a commercial-type heating appliance intended for cord connection does not have an attached cord, the male pins shall not accommodate a conventional flatiron or appliance plug, see 10.2.3.7 and Table 10.4, and a detachable power-supply cord shall be provided with the product.

10.2.1.9 An attached power-supply cord and the cord in a detachable power-supply cord that is provided with a heating appliance shall be of a type indicated in Table 10.3, or shall have such properties that it will be at least as serviceable for the particular application.

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10.2.1.10 A vaporizer intended for use with glycol shall not employ thermoplastic-insulated flexible cord if the construction is such that the cord is likely to be exposed to the vapor.

10.2.1.11 The flexible cord provided with a stock tank de-icer, poultry water heater, or comparable heating appliance intended or likely to be used out of doors shall be suitable for outdoor use and have a type letter suffix of "W-A".

10.2.1.12 Supplementary insulation, if employed on a flexible cord, shall not extend more than 1/2 inch (13 mm) outside the product – unless provided with additional mechanical protection – shall not fray or unravel, and shall not affect adversely the means for providing strain relief.

10.2.1.13 An attachment plug having an Edison screw shell shall not be supplied with a cord-connected product rated at more than 6 A or 660 W.

10.2.1.14 If the power source for a product is electrically separable from the product, both the power source and the product shall be marked in accordance with 45.25.

10.2.1.15 In addition to the requirement in 10.2.1.14, if the power source is not provided with a special connector, or if it is not permanently attached to the product, the power source shall comply with the applicable requirements for that power equipment.

Table 10.3
Acceptable types of cord and applicable limitations of their use

Table 10.3 revised February 13, 2004

Appliance on which the cord is to be used	Cords acceptable where temperatures are more than 121°C (250°F) on any surface that the cord is likely to touch when the appliance is used as intended	Cords acceptable where temperatures are 121°C (250°F) or less on any surface that the cord is likely to touch when the appliance is used as intended
Except as noted below, household heating appliances that are not intended for use outdoors	HPD, HPN, HSJ, HSJOO, or HSJO	HPD, HPN, HSJ, HSJOO, HSJO, SP-2, SPE-2, SPT-2, SV, SVO, SVE, SVOO, SVT, SVTO, SVTOO, SJ, SJO, SJE, SJOO, SJT, SJTO, or SJTOO
Except as noted below, poultry incubators and brooders, sterilizers, glue pots, solder pots, tire vulcanizers, insecticide vaporizers, and other commercial heating appliances that are not intended for use outdoors	HSJ, HSJOO, or HSJO	HSJ, HSJOO, HSJO, SJ, SJO, SJE, SJOO, SJT, SJTO, SJTOO, S, SO, SE, SOO, ST, STO, or STOO
Counter- or table-top laboratory appliances that are not intended for use outdoors, and have a mass not exceeding 1-1/4 lb (0.567 kg) ^a	HPN, HSJ, HSJOO, HSJO	HPN, HSJ, HSJOO, HSJO, SV, SVO, SVE, SVOO, SVT, SVTO, or SVTOO
Barbecue-spit motor Wood-burning appliances (pencils), and 1/2 lb (0.227 kg) and lighter soldering irons, guns or adhesive guns (hot melt) ^a	SJO, SJE, SJOO, SJT, SJTO, or SJTOO TP or TPT maximums: 8 ft (2.4 m) cord, 50 W, and 1/2 lb (0.227 kg)	SJO, SJE, SJOO, SJT, SJTO, or SJTOO TP or TPT maximums: 8 ft (2.4 m) cord and 50 W
Soldering irons or guns and adhesive guns (hot melt), heavier than 1/2 lb (0.227 kg) ^a	SP-1, SPE-1, or SPT-1 (36 AWG or 0.127 mm strands are required) HPD XT (36 AWG or 0.127 mm strands, 20 AWG cord, and the parallel 2-conductor construction are required)	SP-1, SPE-1, or SPT-1 (36 AWG or 0.127 mm strands are required) HPD XT (36 AWG or 0.127 mm strands, 20 AWG cord, and the parallel 2-conductor construction are required)
Soldering irons or guns and adhesive guns (hot melt), heavier than 1/2 lb (0.227 kg) ^a	SP-2, SPE-2, or SPT-2 (36 AWG or 0.127 mm strands are required) SV, SVO, SVE, SVOO, SVT, SVTO, or SJTOO	SP-2, SPE-2, or SPT-2 (36 AWG or 0.127 mm strands are required) SV, SVO, SVE, SVOO, SVT, SVTO, or SVTOO
Heat-sealing irons	HPD, HPN, SJ, SJO, SJE, SJOO, SJT, SJTO, or SJTOO	HPD, HPN, SJ, SJO, SJE, SJOO, SJT, SJTO, or SJTOO
Household vaporizers	HPD, HPN, HSJ, HSJOO, or HSJO	HPD, HPN, HSJ, HSJOO, HSJO, SJ, SJO, SJE, SJOO, SJT, SJTO, or SJTOO
	HPN, HSJ, HSJOO, or HSJO	HPN, HSJ, HSJOO, HSJO, SP-1, SPE-1, SPT-1, SP-2, SPE-2, or SPT-2

^a The weight of the appliance is to be determined without the power-supply cord and, for an adhesive gun, with the adhesive installed.

10.2.2 Strain relief

10.2.2.1 Strain relief shall be provided to restrict a mechanical stress on an attached power-supply cord from being transmitted to terminals, splices, or interior wiring.

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

10.2.2.3 Means shall be provided to restrict an attached power-supply cord from being pushed into the enclosure of a product through the cord-entry hole. To determine compliance, the supply cord shall be tested in accordance with the Push-Back Relief Test, Section 40A.

Revised 10.2.2.3 effective July 16, 1999

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

10.2.3 Pin terminals

10.2.3.1 If a heating appliance is provided with pin terminals, the construction of the product shall be such that live parts will not be exposed to unintentional contact both during and after the placement of the plug on the pins, in the intended manner.

10.2.3.2 A pin guard is required, such that:

- a) A straight edge placed in any position, across and in contact with edges of the plug opening without the plug in place, cannot be made to contact any current-carrying pin.
- b) With the plug aligned with the pins and the face of the plug in a plane located perpendicular to the end or ends of the farthest projecting current-carrying pin, the probe illustrated in Figure 6.4 should not touch any current-carrying pin while the probe is inserted through any opening with the product in any position.

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

10.2.3.4 If a heating appliance employs three or more pin terminals designed for use with a plug that covers all the pins, the terminals shall be so spaced that they will not accommodate a flatiron or appliance plug or cord connector. The plug which these pins will accommodate shall be acceptable for the particular application.

10.2.3.5 A pin terminal shall be securely mounted by means other than friction between surfaces, and shall not shift in position.

10.2.3.6 The requirement in 10.2.3.5 is intended primarily to provide for the maintenance of spacings as given in 25.1.1.1 and Tables 25.1 and 25.2 and to provide for the maintenance of proper spacings between pin terminals. Under this requirement, consideration is also to be given to the means for locking terminals in position to maintain tightness.

10.2.3.7 For a household-type heating appliance, the dimensions of pins and their center-to-center spacings – including the corresponding spacings of the female contacts of general-use plugs that these arrangements of pins will accommodate are as indicated in Table 10.4.

Table 10.4
Pins of appliance and flatiron plugs

Type and rating of plug that accommodates the pins	Configuration of pins			Dimensions of pins	
	Number	Arrangement	Spacing between centers, inch (mm)	Diameter, inch (mm)	Length, inch (mm)
Appliance plug rated 5 A at 250 V and 10 A at 125 V	2	In line	1/2 (12.7)	0.156 ±0.005 (4.0 ±0.13)	9/16 – 5/8 (14.3 – 15.9)
Flatiron plug rated 5 A at 250 V and 10 A at 125 V	2	In line	11/16 (17.5)	0.188 ±0.005 (4.8 ±0.13)	3/4 – 7/8 (19.0 – 22.2)
Jumbo appliance plug rated 10 A at 250 V and 15 A at 125 V	2	In line	1-1/16 (27.0)	0.188 ±0.005 (4.8 ±0.13)	3/4 – 7/8 (19.0 – 22.2)
Reversible plug (for two-heat control) rated 10 A at 250 V and 15 A at 125 V ^a	3	In line	7/8 (22.2)	0.188 ±0.005 (4.8 ±0.13)	3/4 – 7/8 (19.0 – 22.2)
Reversible plug (for two- or three-heat control) rated 10 A at 250 V and 15 A at 125 V ^a	3	One pin at apex of an equilateral triangle	7/8 (22.2)	0.188 ±0.005 (4.8 ±0.13)	3/4 – 7/8 (19.0 – 22.2)

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

10.2.3.8 If a vaporizer is provided with pin terminals, they may be affected adversely by the steam spray or careless filling of the reservoir, consideration is to be given to:

- a) The material on which the pins are mounted,
- b) The proximity of the vapor outlet to the terminals,
- c) The direction of the vapor spray, and
- d) The likelihood of water being present but not necessarily visible at the terminals.

10.2.4 Bushings

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

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

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10.2.4.3 Ceramic materials and some molded compositions are acceptable generally for insulating bushings, but a separate bushing of wood, hot-molded shellac and tar composition, or rubber material (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 moist conditions.

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

- a) The bushing is not less than 3/64 inch (1.2 mm) thick, and
- b) The bushing is so located that it will not be exposed to oil, grease, oily vapor, or other substance having a deleterious effect on the compound employed.

10.2.4.5 A bushing of any of the materials mentioned in 10.2.4.4 may be employed at any point in 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 burrs, fins, and the like.

10.2.4.6 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.

11 Current-Carrying Parts

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

11.2 Current-carrying parts made of corrosion-resistant alloys, for example, stainless steel, are acceptable regardless of temperature. Current-carrying parts made of ordinary iron and steel are not acceptable unless they are rendered corrosion-resistant by a coating and, even then, they are acceptable only as follows:

- a) Pin terminals.
- b) Terminals and other parts of a motor and its governor (if any).
- c) Parts whose normal operating temperature is higher than 100°C (212°F).
- d) Parts of a component that the requirements referred to in 2.1 indicate as being acceptable with coated iron and steel parts.

11.3 A heating appliance that is provided with a reservoir (intended to hold a liquid), shall have all live parts so located or otherwise protected so that they will not be subject to wetting if the reservoir were to leak.

Exception: Live parts need not be so located or protected if the reservoir:

- a) *Is resistant to corrosion from the liquid intended for use in it, and*
- b) *Complies with the applicable requirements in Resistance to Impact, Section 36.*

12 Internal Wiring

12.1 General

12.1.1 The internal wiring of a heating appliance shall consist of wires of a size and 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) Its exposure to oil or grease, and
- c) Other conditions of service to which it is likely to be subjected.

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

12.1.3 Thermoplastic-insulated wire employed for the internal wiring of a heating appliance shall be standard building wire, fixture wire, or appliance-wiring material acceptable for the particular application.

12.2 Protection of wiring

12.2.1 The wiring and connection between parts of a heating appliance shall be protected or enclosed, except that a length of flexible cord may be employed for external connections, or for internal connections that may be exposed during servicing, if flexibility of the wiring is essential. A bare conductor or a conductor with beads for insulation shall not be used outside an enclosure.

12.2.2 Internal wiring which is exposed through an opening in the enclosure of a heating appliance is considered to be protected as required in 12.2.1 if, when judged as if it were enamel-insulated wire, the wiring would be acceptable according to 6.8 – 6.13. Internal wiring within an enclosure is acceptable if, even though it can be touched with the probe, it is so protected or guarded that it cannot be grasped or hooked in such a manner that it could be subjected to stress.

12.2.3 Internal terminals and wiring of a vaporizer may be adversely affected by the steam spray or careless filling of the reservoir. Accordingly, the items mentioned in 10.2.3.8 should be given consideration.

12.2.4 If the wiring of a heating appliance is so located that it may be in proximity to combustible material or may be subjected to mechanical injury, it shall be armored cable or in rigid metal conduit, electrical metallic tubing, metal raceway, or shall otherwise be protected.

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

12.2.6 A hole by means of which insulated wires pass through a sheet-metal wall within the overall enclosure of a heating appliance shall be provided with a smooth, well-rounded bushing or shall have smooth, well-rounded surfaces upon which the wires may bear, so as not to abrade the insulation. A flexible cord used for external interconnection as mentioned in 12.2.1 shall be provided with a strain relief and bushings in accordance with 10.2.2.1 – 10.2.2.4 and 10.2.4.1 – 10.2.4.6 unless the construction is such that the cord will be protected from stress or motion.

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

12.3 Splices

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

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

12.3.3 Insulation consisting of two layers of friction tape, two layers of thermoplastic tape, or of one layer of friction tape on top of one layer of rubber tape, is acceptable on a splice 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 its dielectric properties, heat-resistant and moisture-resistant characteristics. Thermoplastic tape wrapped over a sharp edge is not acceptable.

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

12.4 Separation of circuits

12.4.1 General

12.4.1.1 Unless provided with insulation rated for the highest voltage involved, insulated conductors of circuits connected to separate sources of supply shall be separated by barriers or segregated. Except as described in 12.4.1.3, an insulated conductor of one circuit shall be separated or segregated from any uninsulated live parts of a different circuit.

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

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

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

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

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

2) A construction in which field-installed conductors that do or may have insulation less than the types of wire mentioned in (1) may make contact with low-voltage wiring terminals (see 12.4.2.1) is acceptable, provided that the short-circuiting of such terminals would not result in a risk of fire or electric shock.

12.4.1.3 revised February 13, 2004

12.4.1.4 With respect to 12.4.1.3 (a), if the intended uses of a product are such that in some applications a barrier is required, a removable barrier or one having opening for the passage of conductors may be employed provided instructions for the use of the barrier are a permanent part of the product, and complete instructions in conjunction with a wiring diagram may be acceptable instead of a barrier if, upon investigation, the combination is found to be adequate.

12.4.1.5 Segregation of field-installation conductors from other field-installation conductors and from uninsulated live parts of a product connected to different circuits may be accomplished by arranging the location of the openings in the enclosure for the various conductors— with respect to the terminals or other uninsulated live parts – so that there is no likelihood of the intermingling of the conductors or parts of different circuits. If the number of openings in the enclosure does not exceed the minimum required for the proper wiring of the product, and if each opening is located opposite a set of terminals, it is to be assumed – for the purpose of determining whether the product complies with the requirement in 12.4.1.3 – that the conductors entering each opening will be connected to the terminals opposite the opening. If more than the minimum number of openings are provided, the possibility of conductors entering at points other than opposite the terminals to which they are intended to be connected and contacting insulated conductors or uninsulated current-carrying parts connected to a different circuit is to be investigated. To determine whether the product complies with the requirement in 12.4.1.3, it is to be wired as it would be in service, and in doing so, a reasonable amount of slack is to be left in each conductor, within the enclosure, and no more than average care is to be exercised in stowing this slack in the wiring compartment.

12.4.2 Low-voltage circuit

12.4.2.1 A low-voltage circuit is one involving a potential of not more than 30 V (42.4 volts peak) and supplied by a primary battery, by a standard Class 2 transformer, or by an impedance which, as a unit, complies with all of the performance requirements for a Class 2 transformer.

12.4.2.2 A circuit derived from a source of supply classified in 12.4.3.1 as a line-voltage circuit, by connecting resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low-voltage circuit as described in 12.4.2.1.

12.4.3 Line-voltage circuit

12.4.3.1 A line-voltage circuit is one involving a potential of not more than 600 V and having circuit characteristics in excess of those of a low-voltage circuit.

12.4.4 Barriers

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

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

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13 Heating Elements

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

13.2 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.

13.3 An open-wire element – that is, uninsulated resistance wire – may be used in heating appliances provided it is enclosed or protected by barriers or covers that require tools for removal, and it complies with the accessibility of live parts requirements outlined in 6.13 – 6.17.

13.4 A heating appliance in which the heating element is constructed for use only in an air blast shall be so wired or controlled that the element can be operated only while under the cooling effect of the blast. A product in which the cooling effect of the motion of a part is necessary to limit temperatures shall be so wired or controlled that the element cannot be operated without such motion.

14 Electrical Insulation

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

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

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

15 Thermal Insulation

15.1 Thermal insulation, if employed, shall be of such a nature and so located and mounted or supported that it will not be affected by any intended operation of the product. See 32.1.22.

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

15.3 Some types of mineral-wool thermal insulation contain conductive impurities in the form of slag, which make its use unacceptable if in contact with uninsulated live parts. See 33.1.

16 Motors

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

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

16.3 With reference to the requirement in 16.2, enameled wire is not required to be additionally treated, but fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials should be provided with impregnation or otherwise treated.

17 Overcurrent Protection of Conductors and Heating Elements

17.1 Except as noted in 17.2 and 17.3, each bus bar and insulated wire, including those in heater, motor, and control circuits, in a heating appliance rated at more than 40 A shall be protected by an overcurrent protective device provided as a part of the product. If the product is intended for connection to more than one branch circuit, each section of the product intended for connection to a different branch circuit is to be considered individually in applying the foregoing requirement. The rating of the overcurrent protective device shall be in accordance with Table 17.1.

Table 17.1
Largest acceptable protective device

Kind of conductor	Conductor protected within the appliance		Current rating of largest acceptable overcurrent protective device
	Copper	Aluminum	
Wires	18 – 14 AWG	12 AWG	50 A
	12	–	60
	–	10	80
	10	8	90
	8	6	125
	6	4	175
	4	3	200
Busbars Solid	Copper		Low enough to limit the current density in the busbar to 3000 A/in ² (4.650 A/mm ²) of busbar cross section
	Electrical-conductor (EC) grade of aluminum (conductivity is 61 percent of IACS)		Low enough to limit the current density in the busbar to 2000 A/in ² (3.100 A/mm ²) of busbar cross section
	Aluminum having a conductivity of 55 percent of IACS		Low enough to limit the current density in the busbar to 1776 A/in ² (2.753 A/mm ²) of busbar current cross section

17.2 The requirement in 17.1 does not apply to a conductor:

- a) That is not longer than 10 ft (3.05 m),
- b) That is completely within the enclosure of the product,
- c) That terminates at its load end in one or more overcurrent protective devices, and
- d) That has an ampacity according to the 60°C (140°F) tables in the National Electrical Code, ANSI/NFPA 70, not less than 80 percent of the combined ratings of the one or more overcurrent protective devices supplied by the conductor.

17.3 No overcurrent protective device is required as a part of the product if it is determined that equivalent or better protection will be obtained from the branch-circuit overcurrent protective device through which the product will be supplied.

17.4 The rating of the branch-circuit overcurrent protective device shall be 150 percent of the rating of the product unless the product is marked to specify the use of a protective device having a lower rating. Standard ampere ratings for overcurrent protective devices are 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, and 200. If 150 percent of the rating of the product does not equal one of the standard overcurrent-protective-device ratings mentioned above, then the next lower rating or setting of overcurrent protective device shall be employed.

17.5 The overcurrent protection mentioned in 17.1 – 17.4, 17.6 and 17.7 shall be of a type intended for branch-circuit protection. A fuse used for this purpose shall be a Class CC, G, H, J, K, R, or T cartridge fuse or a plug fuse.

17.6 A product that employs resistance-type heating elements and is rated at more than 48 A shall have the heating elements subdivided. Each subdivided load shall not exceed 48 A and shall be protected at not more than 60 A.

Exception No. 1: Open coil or exposed sheathed-coil types of surface elements in commercial-type heating appliances shall be protected by overcurrent protective devices at not more than 50 A.

Exception No. 2: Infrared lamp commercial and industrial heating appliances shall have overcurrent protection not exceeding 50 A.

Exception No. 3: Water heaters employing resistance-type immersion electric heater elements contained in an ASME-rated and stamped vessel or listed instantaneous water heaters shall be permitted to be subdivided into circuits not exceeding 120 A and protected at not more than 150 A.

17.6 revised February 13, 2004

17.7 The overcurrent protective devices required in 17.6 shall be provided as an integral part of the product or shall be provided by the product manufacturer as a separate assembly, for independent mounting, for use with the product. See 45.26.

17.8 The supplementary overcurrent protective devices required in 17.6 shall be factory-installed within or on the heater enclosure or provided as a separate assembly by the heating appliance manufacturer, shall be accessible, and shall be suitable for branch circuit protection.

17.8 added February 13, 2004

17.9 The main conductors supplying these overcurrent protective devices required in 17.6 shall be considered to be branch-circuit conductors.

17.9 added February 13, 2004

18 Motor-Running Overload Protection

18.1 The following heating appliances in which a 1-hp or smaller motor is used shall incorporate thermal or overload protection so that the motor shall not attain excessively high temperatures under any operating conditions:

- a) A remotely or automatically controlled product.
- b) A permanently connected, continuous-duty, manually started product.

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

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

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

19 Motor and Power-Transformer Short-Circuit and Ground-Fault Protection

19.1 A motor or power transformer in a heating appliance rated at more than 16 A shall be protected against short circuits and grounding by an overcurrent device having a maximum ampere rating in accordance with the National Electrical Code, ANSI/NFPA 70. Such overcurrent protection shall be provided as a part of the heating appliance unless it can be determined in accordance with 17.3 that equivalent overcurrent protection would be incorporated as the branch-circuit protective device.

19.2 The overcurrent protection mentioned in 19.1 shall be of a type indicated as being acceptable for branch-circuit protection.

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

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

20.2 The overcurrent protection mentioned in 20.1 shall be of a type indicated as being acceptable for branch-circuit protection.

20.3 A fuseholder or circuit breaker provided as a part of a heating appliance shall not be accessible without opening a door or cover. However, the operating handle of a circuit breaker, and a removable end cap of a fuseholder, except on a household product, see 20.4, may project outside of the enclosure. A fuseholder shall be so installed that no uninsulated live parts other than the screw shell or clips of the fuseholder are exposed to contact by a person removing or replacing a fuse. If the fuseholder is intended to be accessible only to service personnel, uninsulated live parts other than the screw shell or clips may be exposed if they are guarded, or the fuseholder is so located such that these live parts shall not be subjected to unintentional contact.

20.4 A removable end cap of a fuseholder in a product intended for household use shall not be accessible from the outside of the product.

21 Thermal Cutoffs

21.1 If a heating appliance is provided with a thermal cutoff, it shall be secured in place and shall be so located that it will be accessible for replacement without damaging other connections or internal wiring. See 45.6.

21.2 If a heating appliance is provided with a thermal cutoff, it shall be capable of opening the circuit in the intended manner without causing the short-circuiting of live parts and without causing live parts to become grounded to the enclosure when the product is connected to a circuit of voltage in accordance with 32.1.13, and operated in a normal position to cause abnormal heating.

21.3 To determine whether a thermal cutoff complies with the requirement in 21.2, the product is to be operated with separate cutoffs five times as described above while any other thermally operated control devices in the product are short-circuited. Each cutoff is required to perform acceptably. During the test, the enclosure is to be connected through a 3-A fuse to a supply conductor not containing the cutoff.

22 Lampholders

22.1 If a heating appliance intended for permanent connection to the power supply or a heating appliance equipped with a polarized attachment plug is intended to be connected to the identified (grounded) conductor of a power-supply circuit, a lampholder supplied as a part of the product shall be so wired that the screw shell is connected to the identified conductor.

22.2 Except as noted in 22.3, a lampholder shall be so constructed and installed that uninsulated live parts other than the screw shell will not be exposed to contact by persons removing or replacing lamps.

22.3 The requirement in 22.2 does not apply if, in order to remove or replace a lamp, it is necessary to dismantle the product by means of tools.

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

22.5 Except as noted in 22.6, a screw-shell lampholder for an infrared lamp shall be of the unswitched, medium-base type and shall be used with a 300-W or smaller lamp.

22.6 A lamp-and-lampholder combination need not comply with the requirement in 22.5 if no unacceptable temperature is produced on any of the components in the normal-temperature test, and if the switching mechanism of a switched lampholder is capable of performing acceptably without undue burning, pitting, and the like.

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

Exception: Aluminum (plated or unplated), unplated copper, or unplated copper alloy may be used provided the temperature rise does not exceed 175°C (315°F), based upon a room ambient temperature of 25°C (77°F), as measured with the product operating under the most adverse conditions of normal operation until thermal equilibrium is attained. All temperature regulating controls, if provided, shall be set at the maximum setting. Unplated aluminum shall only be used in equipment intended for indoor dry locations.

23 Switches

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

23.2 A switch employed on a heating appliance shall be so located or protected that it will not be subjected to mechanical damage during use.

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

23.4 A switch on a cord-connected heating appliance incorporating an open-wire heating element construction shall be of such a type and so connected that it will disconnect the element or elements that it controls from all conductors of the supply circuit.

23.5 The requirement in 23.4 applies to a switch in the off position or any other setting in which the element is not heated, and also to a through-cord switch or a plug in which a switch is incorporated in an attached or detachable power-supply cord that is provided with such a heating appliance.

23.6 A switch or other device controlling one or more elements of a heating appliance intended for permanent connection to the power supply shall be so arranged that the opening of the switch will disconnect all of the ungrounded conductors of the supply circuit, unless there will be no live parts exposed to unintentional contact when the switch is open or unless the fact that such parts are alive is definitely apparent.

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

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

23.9 Except as noted in 23.10, a switch shall not be incorporated in a wooden handle or in other combustible material unless enclosed in metal or insulating material.

23.10 In a small, low-wattage product such as a wood burning pencil, a switch may be acceptable in a wooden handle.

23.11 If a heating appliance that is intended for connection to the supply circuit by means of flexible cord and an attachment plug employs a motor rated at more than 1/3 hp, a manually operated motor controller shall be provided in the product.

23.12 A manually operated, line-connected, single pole switch, or other control device, intended for appliance on-off operation shall be connected to the ungrounded conductor of the power-supply cord. Table 10.2 specifies the polarity identification of the power-supply cord conductors.

24 Automatic Controls and Control Circuits

24.1 A control circuit shall comply with the requirements in 12.4.1.1 – 12.4.2.2.

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

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

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

24.5 A control device shall not be constructed to deliberately overload the branch-circuit protective device as a means of disconnecting the product from the supply.

24.6 A contactor or similar device, such as a silicon controlled rectifier, required for use with a limit control shall be provided by the manufacturer of the product, but need not be mounted on the product. See 45.26.

24.7 The terminals of a device mentioned in 24.4 within the enclosure of a heating appliance shall be so located or further enclosed that they will be protected against unintentional short circuiting and damage.

25 Spacings

25.1 Line-voltage circuits

25.1.1 General

25.1.1.1 Except as noted in 25.1.1.2 – 25.1.1.4, the spacings in a heating appliance shall be in accordance with Tables 25.1 and 25.2.

Table 25.1
Minimum acceptable spacings at field-wiring terminals^{a,b}

Parts involved	Potential involved in volts	Through air, inch (mm)	Over the surface, inch (mm)
Between live parts of opposite polarity and between a live part and a dead metal part, other than the enclosure, which may be grounded	0 – 250	1/4 (6.4)	3/8 (9.5)
Between a live part and the enclosure	251 – 600	3/8 (9.5)	1/2 ^c (12.7 ^c)
	0 – 600	1/2 (12.7)	1/2 (12.7)

^a These spacings do not apply to connecting straps or busses extending away from wiring terminals. Such spacings are to be judged under Table 25.2.

^b Applies to the sum of the spacings involved where an isolated dead part is interposed.

^c A spacing of not less than 3/8 inch (9.5 mm), through air and over the surface, is acceptable at wiring terminals in a wiring compartment or terminal box if the compartment or box is integral with a motor.

Table 25.2
Minimum acceptable spacings through air or over the surface at points other than field-wiring terminals or inside motors^a

Parts involved	Potential involved in volts	inch (mm)
Between uninsulated live metal parts of opposite polarity; and between a rigidly mounted uninsulated live metal part and a dead metal part that either is exposed for persons to contact or may be grounded	0 – 250	1/16 (1.6)
	251 – 600	1.4 ^{b,c} (6.4) ^{b,c}

^a If an uninsulated live part is not rigidly supported, or if a moveable dead metal part is in proximity to an uninsulated live part, the construction shall be such that at least the minimum acceptable spacing of 1/16 inch (1.6 mm) is maintained under all operating conditions and under all normal conditions of handling.

^b Enamel-insulated wire is considered to be an uninsulated live part. However, a spacing of not less than 3/32 inch (2.4 mm) – over the surface and through air – is acceptable between a dead metal part and enamel-insulated wire rigidly supported and held in place on a motor coil.

^c A spacing 1/16 inch (1.6 mm) is permissible at the heating element only, in a heater rated for 300 V or less.

25.1.1.2 The spacings specified in Tables 25.1 and 25.2 do not apply to the inherent spacings of a component part of a heater; such spacings are judged under the requirements for the component in question.

25.1.1.3 The spacings within a motor shall comply with the requirements in the Standard for Electric Motors, UL 1004.

25.1.1.4 At closed-in points only, such as the screw-and-washer construction of an insulated terminal mounted in metal, a spacing of 3/64 inch (1.2 mm) is acceptable in a product rated at 250 V or less. Within a thermostat, except at contacts, the spacings between uninsulated live parts on opposite sides of the contacts are to be not less than 1/32 inch (0.8 mm) through air and 3/64 inch (1.2 mm) over the surface of insulating material, and the construction is to be such that the spacings will be maintained permanently.

25.1.2 Barriers

25.1.2.1 Except as noted in 25.1.2.2, an insulating liner or barrier of fiber or similar material employed where spacings would otherwise be unacceptable shall not be less than 1/32 inch (0.8 mm) thick and shall be so located or of such material that it cannot be affected by arcing, except that 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 spacing required for air alone.

25.1.2.2 Insulating material having a thickness less than specified in 25.1.2.1 may be used if it is equivalent in appropriate properties.

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

25.2 Low-voltage circuits

25.2.1 Limiting controls

25.2.1.1 The spacings in a low-voltage limiting control shall comply with the requirements in 25.1.1.1 – 25.1.2.3 and Tables 25.1 and 25.2.

25.2.2 Other than limiting controls

25.2.2.1 The spacing between uninsulated live parts of opposite polarity and between such parts and dead metal that may be grounded in service is not specified for parts of circuits that are classified as low-voltage in 12.4.2.1.

26 Grounding

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

26.2 In a product intended for permanent connection to the power supply by means other than a metal-enclosed wiring system, such as nonmetallic-sheathed cable:

- a) An equipment-grounding terminal or lead shall be provided (see 10.1.2.13 and 10.1.2.14), and
- b) All exposed dead metal parts and all dead metal parts inside the enclosure that are exposed to contact during any servicing operation – including maintenance and repair – that are likely to become energized shall be conductively connected to such terminal or lead.

26.3 On a portable product where grounding is required or provided, the power-supply cord or cord set shall include a grounding conductor that shall be:

- a) Green with or without one or more yellow stripes,
- b) Connected to the grounding blade of an attachment plug of a grounding type, and
- c) Connected to the enclosure of the product by means of a screw not likely to be removed during servicing, or by other equivalent means. Solder alone is not acceptable for making this connection.

26.4 If any accessible dead metal part of a product is grounded, all accessible dead metal parts that are likely to become energized, including those exposed during any servicing operation – including maintenance and repair – shall be grounded.

26.5 A cord-connected heating appliance constructed for operation on a circuit involving a potential of more than 150 V to ground shall have provision for grounding, in accordance with 26.3, of all exposed dead metal parts, and all dead metal parts exposed during any servicing operation – including maintenance and repair – that are likely to be energized.

26.6 A cord-connected stock-tank de-icer, poultry-water heater, branding iron, dehorning iron, poultry cauterizer, charcoal ignitor, incubator, and brooder, or similar device intended for outdoor use, and a refrigerator defroster and heat gun shall either:

- a) Be double insulated, or
- b) Have provision for grounding dead metal parts in the form of a grounding conductor in the cord and a grounding type of attachment plug, in accordance with 26.3 (see also 45.10).

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

26.7 A cord-connected, 2-wire heating appliance intended to operate at a nominal potential of 240 V – and similarly any other potential within the 220 – 250 V range – is considered as requiring provision for grounding in accordance with 26.3 unless the marked rating on the product is 120/240 V or unless the product is otherwise marked to indicate that it is to be connected only to a 120/240-V circuit with a grounded neutral.

27 Pressure Vessels and Parts Subject to Pressure

27.1 Except as noted in 27.2, a pressure vessel having an inside diameter of more than 6 inches (152 mm) and subject to a pressure of more than 15 lbf/in² (103 kN/m²) shall be certified by the National Board of Boiler and Pressure-Vessel Inspectors and marked in accordance with the appropriate boiler and pressure vessel code symbol ("H", "M", "S", or "U") of the American Society of Mechanical Engineers (ASME) for a working pressure no less than the pressure determined by applying 27.3.

27.2 If a pressure vessel, because of its application, is not covered under the inspection procedures of the ASME code, it shall be so designed and constructed that it will comply with the requirements in 27.3.

27.3 Except as noted in 27.4 and 27.5, a part that is subject to air or vapor pressure, including the vapor pressure in a vessel containing only a superheated fluid, during normal or abnormal operation shall withstand without bursting or leaking a pressure equal to the highest of the following that is applicable:

- a) Five times the pressure corresponding to the maximum setting of a pressure-reducing valve provided as part of the assembly, but not more than five times the marked maximum supply pressure from an external source and not more than five times the pressure setting of a pressure-relief device provided as part of the assembly.
- b) Five times the marked maximum supply pressure from an external source, except as provided in (a).
- c) Five times the pressure setting of a pressure-relief device provided as part of the assembly.
- d) Five times the maximum pressure that can be developed by an air compressor that is part of the assembly, unless the pressure is limited by a pressure-relief device in accordance with (a).
- e) Five times the working pressure marked on the part.

27.4 A test need not be performed to determine whether a part complies with the requirement in 27.3 if study and analysis of the material and dimensions indicate that the part has the strength acceptable for the application – for example, copper or steel pipe of standard size and provided with standard fittings might be considered to have the strength for the application.

27.5 A pressure vessel bearing the ASME code inspection symbol ("H", "M", "S", or "U") is considered to comply with the requirement in 27.3 if the vessel is marked with a value of working pressure not less than that to which it is subject during normal or abnormal operation.

27.6 If a test is necessary to determine whether a part complies with the requirement in 27.3, two samples of the part are to be subjected to a hydrostatic-pressure test. Each sample is to be so filled with water as to exclude air and is to be connected to a hydraulic pump. The pressure is to be raised gradually to the specified test value and is to be held at that value for 1 minute. The results are not acceptable if either sample bursts or leaks, except as indicated in 27.7.

27.7 Leakage at a gasket during the hydrostatic-pressure test is acceptable if it does not occur at a pressure 40 percent or less of the required test value.

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

27.9 Pressure-relief devices (see 27.15), fusible plugs, soldered joints, nonmetallic tubing, or other pressure-relief means or the equivalent may be employed to comply with the requirements in 27.8.

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

27.11 A vessel having an inside diameter of more than 3.0 inches (76.2 mm) and subject to air or steam pressure generated or stored within the product shall be protected by a pressure-relief device.

27.12 The start-to-discharge pressure setting of the pressure-relief device shall not be higher than the working pressure marked on the vessel. The discharge rate of the device shall be capable of relieving the pressure.

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

- a) It shall be connected as close as possible to the pressure vessel or parts of the system that it is intended to protect.
- b) It shall be so installed that it is readily accessible for inspection and repair and cannot be readily rendered inoperative.
- c) It shall have its discharge opening so located and directed that the risk of scalding is reduced to a minimum.
- d) It shall have its discharge opening so located and directed that operation of the device will not deposit moisture on bare live parts or on insulation or components affected by moisture.

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

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

27.16 Where a pressure-relief device is required, the control responsible for limiting the pressure in the vessel shall be capable of performing under rated load for 100,000 cycles of operation and the control shall limit the pressure so that it does not exceed 90 percent of the relief device setting under any condition of intended operation.

28 Protection Against Injury to Persons

28.1 Materials employed in the construction of the product that reduce the risk of injury to persons shall be acceptable for the particular use. See 6.1 and 6.5.

28.2 All heating appliances, or any items furnished with the product, shall have no sharp edges, burrs, points, or spikes inside or outside the product, that may present a risk of injury to persons during use, including cleaning operations.

28.3 The temperature of a surface that is likely to be contacted by the user – other than a heating function surface and an adjacent surface known to be hot because of its proximity to a heating function surface – shall not be more than the value specified in Table 32.2 when measured in accordance with the applicable requirements in the Normal Temperature Test, Section 32.

Exception: Accessible surfaces, other than handles or knobs, may have temperatures that exceed those shown in Table 32.2 if marked in accordance with 45.35.

PERFORMANCE

29 General

29.1 The performance of a heating appliance shall be investigated by subjecting the requisite number of specimens to all the applicable tests as described in Sections 30 – 41. Insofar as practicable, the tests shall be conducted in the order in which they are presented here. Specimens employed for leakage-current tests shall be first tested for leakage prior to employing the specimens for other tests.

29.1 revised July 17, 1998

30 Power Input Test

30.1 The power input to a heating appliance shall not be more than 105 percent of its marked rating.

30.2 To determine whether a heating appliance complies with the requirement in 30.1, the power input is to be measured with the product at normal operating temperature under full-load conditions and while connected to a supply circuit adjusted to be the highest of the following:

- a) The marked voltage rating, or
- b) The highest voltage of the applicable range of voltages specified in 44.1 if the marked voltage is within one of the voltage ranges indicated in 44.1.

If a product employs a nonmetallic element, such as carbon, the power input is to be determined for a new element.

30.3 In a test to determine whether a heating appliance of the immersed-electrode type complies with the requirement in 30.1, the hard-water solution described in 31.10 is to be used.

31 Leakage Current

31.1 The leakage current of a cord-connected product rated for a nominal 120-, 208-, or 240-V supply when tested in accordance with 31.3 – 31.8 shall not be more than:

- a) 0.5 mA for an ungrounded (2-wire) product,
- b) 0.5 mA for a grounded (3-wire) portable product, and
- c) 0.75 mA for a grounded (3-wire) product intended to be fastened in place or located in a dedicated space and employing a standard attachment plug rated 20 A or less.

Exception: During heat-up and cool-down, as defined in Table 1 of Leakage Current for Appliances, ANSI C101.1-1992, the leakage current of a product employing a sheath-type heating element, when measured in accordance with 31.3 – 31.8, may exceed 0.5 mA or 0.75 mA, as applicable, but shall not exceed 2.5 mA during a period of 5 minutes beginning with the moment the leakage current exceeds 0.5 mA or 0.75 mA, as applicable. At the end of the 5 minute period, the leakage current shall not be more than 0.5 mA or 0.75 mA, as applicable.

31.2 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.

31.3 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible and from one surface to another where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure considered acceptable for protection against a risk of electric shock as defined in 6.1 – 6.17. Surfaces are considered to be simultaneously accessible when they can be contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltage levels that do not involve a risk of electric shock.

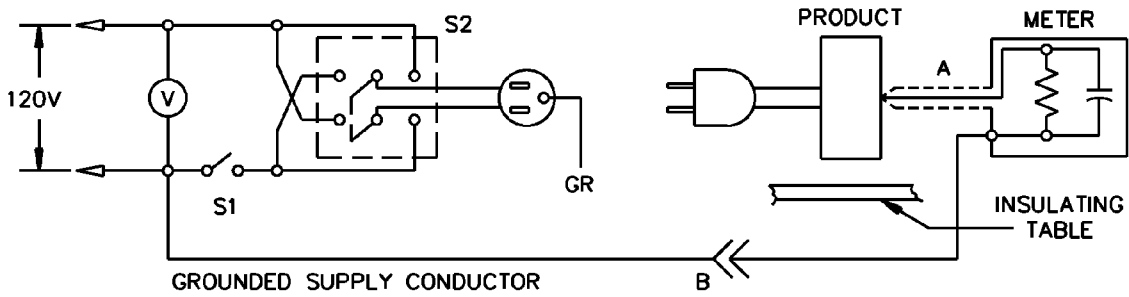
31.4 If a conductive surface other than metal is used for the enclosure or part of the enclosure, the leakage current is to be measured using a metal foil with an area of 10 by 20 cm in contact with surface. Where the surface is less than 10 by 20 cm, the metal foil is to be the same size as the surface.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

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

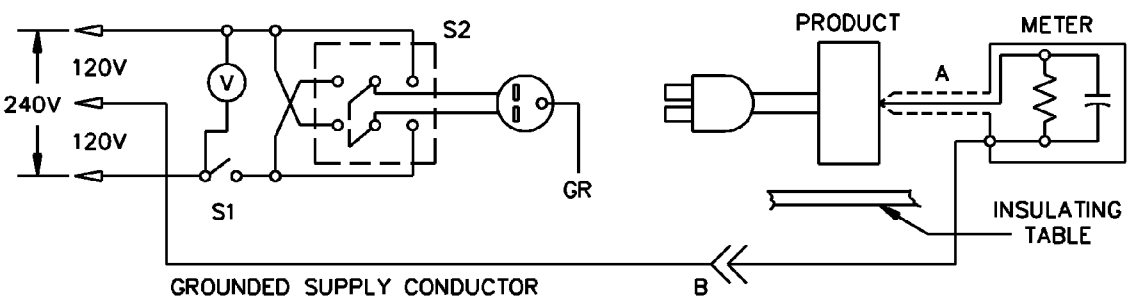
31.6 The measurement circuit for leakage current is to be as shown in Figure 31.1. The ideal measurement instrument is defined in (a) – (d). The meter which is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the ideal instrument. The meter used need not have all the attributes of the ideal instrument.

- a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 μ F.
- b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor.
- c) Over a frequency range of 0 – 100 kHz, the measurement circuitry is to have a frequency response, ratio of indicated to actual value of current, that is equal to the ratio of the impedance of a 1500 ohm resistor shunted by a 0.15 (F) capacitor to 1500 ohms. At an indication of 0.5 or 0.75 mA, the measurement is to have an error of not more than 5 percent at 60 Hz.
- d) Unless the meter is being used to measure leakage from one part of a product to another, the meter is to be connected between the accessible parts and the grounded supply conductor.

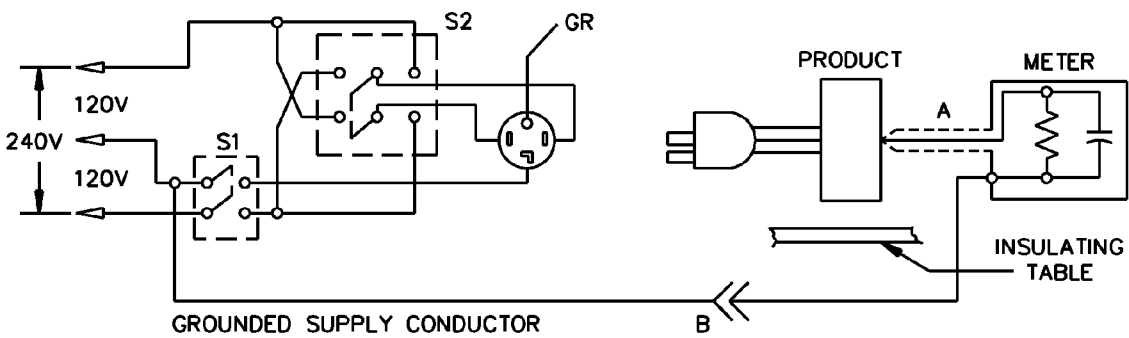
Figure 31.1
Leakage-current measurement circuit



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



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



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

NOTES -

A - Probe with shielded lead.

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

LC300N

31.7 A sample of the product is to be tested for leakage current starting with the as-received condition with all its switches and thermostats closed, but with its grounding conductor, if any, open at the attachment plug. The as-received condition is defined as being without prior energization, except as may occur as part of the production-line testing. The supply voltage is to be 120, 208, or 240 V depending on product rating. The test sequence, with reference to the measuring circuit, Figure 31.1, 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.
- b) Switch S1 is then to be closed, energizing the appliance, and within a period of 5 seconds, the leakage current is to be measured using both positions of switch S2, and with the product operated at the maximum heat setting of controls.
- c) Leakage current is to be monitored from the time the appliance is energized until the product reaches thermal stabilization. Both positions of switch S2 are to be used. The equivalent of thermal stabilization is considered to be obtained as in the normal temperature test. If any thermostat does not cycle at the maximum heat setting, it is to be adjusted until it does cycle before the final measurements are taken. Measurements are to be made with the thermostat, if any, open and closed. Upon evidence of stabilizing readings, intervals between measurements may be increased.
- d) Monitoring of leakage current is to continue until the leakage current stabilizes or decreases after the product is turned off.

31.8 A sample will be carried through the complete leakage-current test program as covered by 31.7, without interruption for other tests. However, with the concurrence of those concerned, the leakage-current tests may be interrupted for the purpose of conducting other nondestructive tests.

31.9 When intended for permanent connection to the power supply, a liquid-heating appliance of the electrode type and a product in which live parts of the heating element are in contact with the liquid shall not have a leakage current to ground in excess of 0.5 A with current flowing through the element or with one side of the line open as explained in 31.10.

31.9 revised July 17, 1998

31.10 To determine whether a liquid-heating appliance complies with the requirement in 31.9, the product is to be connected to a grounded supply circuit having full rated voltage between the ungrounded side of the line and ground. The case is to be so mounted that it will be insulated from ground, and the liquid is to be supplied by means of a rubber tube. A solution of 0.5 gram of calcium sulphate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) per liter of distilled water is to be employed for the testing of a water heater constructed for general use. An ammeter is to be placed between the pipe connections on the heater and the water pipe or other ground, and leakage readings are to be observed under all conditions representing an open fuse or fuses, except that in the case of a heater constructed and marked for use with a solid (unfused) and grounded neutral, the grounded conductor need not be disconnected.

31.11 The greatest leakage current is usually noted with the maximum water temperature that, in the case of an instantaneous or faucet heater, may be obtained by reducing the flow of water to a minimum.

31.12 The leakage current of a cord-connected liquid-heating appliance of the electrode type, or a product in which live parts of the heating element are in contact with the liquid, shall be investigated with reference to the inherent leakage current occurring during conditions of normal and abnormal use.

32 Normal Temperature Test

32.1 General

32.1.1 A heating appliance, when tested under the conditions described in 32.1.3 – 32.2.12.1 shall comply with all four of the following conditions:

- a) The product shall not attain at any point a temperature that would constitute a risk of fire or damage to any materials employed in the product.
- b) At any time during the test, other than as indicated in 32.1.2, temperature rises at specific points shall not be greater than indicated in Table 32.1.
- c) The product shall comply with the requirement in 6.1.
- d) The product shall comply with the requirements in 28.3 (see Table 32.2).

32.1.2 Initial temperature transients may be in excess of the value shown in Table 32.1 if the duration and extent of the excursion do not result in a risk of fire or electric shock and do not unduly shorten the life of the product.

32.1.3 All values in Table 32.1 are based on an assumed room ambient temperature of 25°C (77°F), but a test may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F). However, if the operation of an automatic thermal control during the test limits the temperatures under observation, no temperature higher than 25°C plus the specified maximum rise is acceptable.

32.1.4 A gasket that is depended upon to keep water from entering into a heating appliance during cleaning shall not become hard or brittle, shall not crack, and shall show no other signs of deterioration as a result of an accelerated-aging test in which the gasket is subjected to elevated temperatures. See 33.14.

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

Table 32.1
Maximum acceptable temperature rises

Materials and component parts		°C (°F)
1.	Any point within a terminal box or wiring compartment of a permanently connected heating appliance in which field-installed conductors are to be connected (including such conductors themselves) unless the product is marked in accordance with 45.7.	35 (63)
2.	Any point on a surface adjacent to a heating appliance that is: a) Permanently connected electrically or b) Cord-connected and intended to be fastened in place or located in a dedicated space – including the surface on which the product is mounted, and specified points on test surfaces and enclosures at designated clearances from the product.	65 (117)
3.	Fuses	65 (117)
4.	Fiber used as electrical insulation or as cord bushings	65 (117)
5.	Wood or other combustible material which is part of a heating appliance	65 (117)
6.	Cotton or rayon braid of flexible cord	65 (117)
7.	Class 105 insulation systems on winding of relays or solenoids, and the like:	65 (117)
	Thermocouple method	
	Resistance method	85 (153)
8.	Class A insulation systems on coil windings of a-c motors having a frame diameter of more than 7 inches (178 mm) and of d-c and universal motors ^{a,b} :	
	a) In open motors:	
	Thermocouple method	65 (117)
	Resistance method	75 (135)
	b) In totally enclosed motors	
	Thermocouple method	70 (126)
	Resistance method	80 (144)
9.	Class A insulation systems on coil windings of a-c motors (not including universal motors) having a frame diameter of 7 inches (178 mm) or less and on vibrator coils – thermocouple or resistance method ^{a,b} :	
	a) In open motors and on vibrator coils	75 (135)
	b) In totally enclosed motors	80 (144)
10.	Class 130 insulation systems on winding of relays, solenoids, and the like:	
	Thermocouple method ^a	85 (153)
	Resistance method	105 (189)

Table 32.1 Continued on Next Page

Table 32.1 Continued

Materials and component parts		°C (°F)
11.	Class B insulation systems on coil windings of a-c motors having a frame diameter of more than 7 inches (178 mm) and d-c and universal motors ^{a,b} : a) In open motors: Thermocouple method Resistance method b) In totally enclosed motors: Thermocouple method Resistance method	85 (153) 95 (171) 90 (162) 100 (180)
12.	Class B insulation systems on coil windings of a-c motors (not including universal motors) having a frame diameter of 7 inches (178 mm) or less and on vibrator coils – thermocouple or resistance method ^{a,b} : a) In open motors and on vibrator coils b) In totally enclosed motors	95 (171) 100 (180)
13.	Phenolic composition used as electrical insulation or where deterioration would result in risk of fire, electric shock, or injury to persons ^c	125 (225)
14.	Points on surface supporting a cord-connected heater	125 (225)
15.	Flatiron or appliance ring	175 (315)
16.	Insulated wire or cord	25°C (45°F) less than its temperature rating ^d
17.	Sealing compound	e
18.	Copper conductors, bare or insulated, without a nickel coating or other protection	125 (225)
19.	Termination of copper conductor and pressure terminal connector without being nickel-coated or otherwise protected	125 (225)
20.	Water in reservoir for vaporizer ^f	29 (53)
21.	Lampholder or heating element holder female screwshell, center contact, or other connecting device of aluminum (plated or unplated), unplated copper or unplated copper alloy ^g .	175 (315)
^a See 32.1.11 and 32.1.12. ^b The frame diameter is the diameter, measured in the plane of the laminations of the circle circumscribing the stator frame, excluding lugs, boxes, and the like, used solely for motor mounting, assembly, or connection. ^c The limitation on phenolic composition does not apply to a compound which has been investigated and found to have special heat-resistant properties. ^d Inside a heating appliance, the temperature rise on a wire or cord may be greater than the specified maximum rise, provided that the insulation on each individual conductor is protected by supplementary insulation (such as braid, wrap, tape, or close-fitting tubing) which is appropriate for the temperature and the type of insulation involved. ^e 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 Standard Test Methods for Softening Point by Ring-and-Ball Apparatus, ASTM E28-96. ^f The water temperature is to be measured by a thermocouple floated approximately 3/16 inch (5.0 mm) beneath the surface of the solution and located midway between the outer surface of the electrode enclosure and the inner surface of the water reservoir. The vaporizer is to be tested in a room ambient of 25°C (77°F). ^g See 22.7 concerning the use of aluminum (plated or unplated), unplated copper, or unplated copper alloy.		

Table 32.2
Maximum surface temperatures^a

Table 32.2 revised November 17, 1997

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

^a If the test is conducted at a room temperature of other than 25°C (77°F), the results are to be corrected to that temperature.
^b A handle, knob, or the like, made of a material other than metal, that is plated or clad with metal having a thickness of 0.005 inch (0.127 mm) or less is considered to be, and is judged as, a nonmetallic part.

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

32.1.7 A vaporizer, insecticide or medicament, shall not subject the stored or vaporized chemical to temperatures likely to result in ignition.

32.1.8 Temperatures are to be measured by thermocouples consisting of wires not larger than 24 AWG (0.21 mm²) and not smaller than 30 AWG (0.05 mm²), except that a coil temperature may be determined by the change-of-resistance method if the coil is inaccessible for mounting thermocouples. When thermocouples are used in determining temperatures in electrical equipment, it is standard practice to employ thermocouples consisting of 30 AWG (0.05 mm²) iron and constantan wire and a potentiometer-type instrument, and such equipment is to be used whenever referee temperature measurements by thermocouples are necessary. The thermocouple wire is to conform with the requirements listed in the Initial Calibration Tolerances for Thermocouples table in Temperature-Measurement Thermocouples, ANSI/ISA MC96.1. The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice.

32.1.8 revised February 13, 2004

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

- a) 5 minutes, or
- b) 10 percent of the total test time elapsed previous to the start of the first interval.

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

32.1.11 The temperature of a coil or winding is to be measured by means of thermocouples mounted on the outside of the coil wrap. If the coil is inaccessible for mounting thermocouples, for example, a coil immersed in sealing compound, or if the coil wrap includes thermal insulation, or more than 1/32 inch (0.8 mm) of cotton, paper, rayon, or similar insulation, the change-of-resistance method is to be used. For the thermocouple-measured temperature of a coil of an alternating-current motor, other than a universal motor, having a frame diameter of 7 inches (178 mm) or less (items 9 and 12 in Table 32.1), the thermocouple is to be mounted on the integrally applied insulation of the conductor.

32.1.12 At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature rise measured by means of a thermocouple may be higher by the following amount than the maximum indicated in Table 32.1, provided that the temperature rise measured by the change-of-resistance method does not exceed the values indicated in Table 32.1:

Item in Table 32.1	Additional thermocouple rise °C (°F)
Item 7 and part (a) of item 8	15 (27)
part (a) of item 9	5 (9)
part (a) of item 11	20 (36)
part (a) of item 12	10 (18)

If the coil wrap is not caused to exceed its temperature limitation by radiation from an external source, the temperature of the coil may be measured by means of a thermocouple on the integral insulation of the coil conductors.

32.1.13 To determine whether a heating appliance complies with the requirements in 32.1.1, the product is to be operated continuously until constant temperatures have been reached. The test voltage is to be the highest of the following:

- a) The marked voltage rating, or
- b) The highest voltage of the applicable range of voltages specified in 44.1 if the marked voltage is within one of the voltage ranges indicated in 44.1.

32.1.14 Unless a particular voltage or other test condition is specified in 32.2.1.1 – 32.2.12.1, the test voltage specified in 32.1.13 is to be increased, if necessary, to cause the wattage input to the product to be equal to the wattage rating marked on the product.

32.1.15 If a heating appliance employs a motor in addition to a heating element, the voltage applied to an integrally connected motor is to be the test voltage as specified in 32.1.13. A motor supplied from a separate circuit is to be connected to a test voltage derived from its marked rated voltage in accordance with 32.1.13.

32.1.16 In conducting a test to determine whether a heating appliance complies with the temperature requirements, it is to be mounted or supported as in service and tested under conditions approximating those of normal operation, except as otherwise noted. Temperatures are to be observed on nearby surfaces, on the supporting surface, at points of support, on attachment plugs, and at other points as may be necessary, including building wiring that may be located adjacent to or behind a permanently installed product.

32.1.17 A heating appliance intended to be permanently connected to the power supply or a product that is cord-connected and that is intended to be fastened in place or located in a dedicated space is to be supported in the intended manner on black-painted wood not less than 3/8 inch (9.5 mm) thick and is to be located in a corner – vertical walls meeting at a right angle – formed by two black-painted, vertical sheets of 3/8-inch (9.5-mm) plywood having such width and height that they extend not less than 2 ft (610 mm) beyond the physical limits of the heater. The heater is to be located as close to both walls of the corner as its construction permits, and it is to be so placed relative to the walls that maximum heating of the walls will occur, except that it may be spaced away from the walls to limit the wall temperatures from rising more than 65°C (117°F) if the heater is marked as described in 45.9.

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

32.1.19 An automatic temperature-regulating or -limiting control or other protective device is to be shunted out of the circuit, unless the control has been shown, in accordance with Table 38.1, to be rugged, reliable, and unlikely to be defeated by the user. The control is considered to be unlikely to be defeated if tools are required to gain access to the control, or a positive stop is incorporated in the control.

32.1.20 If the construction of a heating appliance is such that cooking or heating of a liquid is a determining factor in the temperature attained, the intended duty of a product is to be taken into consideration. Normal operating conditions cannot be obtained, however, if certain types of products are operated continuously and in a dry condition. Accordingly, in determining whether a product complies with the requirements in 32.1.1, actual service conditions or an approximation thereof are to be employed. Unless otherwise specifically indicated below:

- a) If the appliance is controlled by an adjustable thermostat, the thermostat is to be set to give maximum temperatures, and
- b) If the product is controlled by a nonadjustable thermostat, it is to operate at whatever temperature the thermostat permits.

In each case, operation is to be continued until temperatures are stabilized.

32.1.21 A product that may be either open or closed in actual service, such as a heat transfer press, is to be tested both open and closed to determine which condition produces the higher operating temperature. In the case of an open-front tabletop product, where some heating operation may be performed without a tray in place, temperatures are to be measured on the horizontal supporting surface in front of the open face of the product.

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

32.1.23 Wherever cheesecloth is mentioned in connection with either a temperature test or an abnormal test, the cloth is to be bleached cheesecloth running 14 – 15 yd/lb (approximately 28 – 30 m/kg) and having what is known to the trade as a "count of 32 x 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 threads in the other direction).

32.2 Specific test conditions

32.2.1 General

32.2.1.1 For most of the common types of heating appliances, standardized normal conditions for the temperature tests are given in 32.2.2.1 – 32.2.11.1.

32.2.2 Ceramics-baking kilns and ovens

32.2.2.1 If marked with a warning statement as indicated in 45.17, the product is to be operated until the internal temperature reaches a value indicated in that statement, and the power supply is then to be cut off. Temperatures are to be recorded over such interval as may be necessary to determine that the maximums have been observed. In the absence of the marking mentioned above, the product is to be operated until observed temperatures have become stabilized, and they are then to be recorded.

32.2.3 Charcoal ignitors

32.2.3.1 A cord-connected charcoal ignitor is to be operated until maximum temperatures are reached in a brazier-held conical bed of charcoal briquettes that is 18 inches (457 mm) in diameter and 4 inches (102 mm) high. The diameter of the brazier is to be 24 inches (610 mm) and the bed of charcoal is to be located tangent to the brazier rim. The center of the area enclosed by the heated ignitor element is to be located as close to the center of the bed of charcoal as the length of the heating element permits but, in any case, the handle of the ignitor is to be outside the rim of the brazier at the point at which the charcoal bed is tangent to the rim. At the conclusion of the normal temperature test, operation is to be continued as described in 38.2.4.2.

32.2.4 Stock-tank de-icers, stock waterers, and the like

32.2.4.1 A device intended for heating in low-temperature air is to be operated in the intended manner while in air at 25°C (77°F) and while in air at minus 23.0 ±3.0°C (minus 9.4 ±5.4°F). The temperature limitations are to be those indicated in Table 32.1 plus 25°C.

32.2.5 Liquid heaters and vaporizers, cord-connected

32.2.5.1 The product is to be operated continuously with water. If the product is of the immersed-electrode type, a hard water solution of:

- a) 0.5 gram of calcium sulphate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) per liter of distilled water and
- b) 0.25 gram of calcium sulphate per liter of distilled water plus the manufacturers' amount and type of recommended additive

are to be used in separate tests starting with the water reservoir or container filled to its filled level mark. Operation is to be continued after temperatures have stabilized and until 75 percent of the water reservoir supply has been dissipated, while monitoring the reservoir water temperature, see item 20 of Table 32.1.

32.2.6 Poultry and livestock brooders

32.2.6.1 If marked in accordance with 45.20, a brooder is to be tested while mounted at the height above the supporting surface recommended by the manufacturer. A brooder not so marked is to be tested while mounted as close to the supporting surface as its construction will permit. If the product has an adjustable temperature control, it is to be set at the value recommended by the manufacturer.

32.2.7 Soldering irons and soldering guns and desoldering tools

32.2.7.1 A product equipped with a momentary-contact switch, such as a high-speed resistance-type soldering iron or a transformer-type soldering gun, is to be tested as follows. The product is to be connected to a circuit that provides the test voltage indicated in 32.1.13 and is to be supported at an angle of 45 degrees from the horizontal with its tips resting in a pool of solder approximately 1/2 inch (13 mm) in diameter. It is to be operated in cycles of 1 minute on and 4 minutes off until stabilized temperatures are attained. An iron or desoldering tool of any other type is to be operated continuously until temperatures become stabilized, while resting on its stand with the applied voltage reduced to give a temperature of 275°C (527°F) at the tip.

32.2.8 Solder pots, nonautomatic

32.2.8.1 For a nonautomatic solder pot in which means are provided to adjust the heat to values for melting different metals or alloys, and that is plainly and permanently marked to indicate which wattage setting should be used for each metal or alloy, the test is to be performed as follows: the solder pot is to be operated at each setting until temperatures become stabilized, while charged with the metal or alloy corresponding to that setting, as indicated in the marking.

32.2.9 Warming trays

32.2.9.1 Warming trays, intended to receive only vessels on the heated surface, are to be operated continuously with the thermostat set at the maximum-heat position and with the surface empty. If the thermostat cycles, the test is to be repeated with a vessel – containing water to a minimum depth of 1 inch (25 mm) – placed on the heating surface over the thermostat. The vessel will usually consist of a 6-inch (152-mm) diameter shallow pan.

32.2.10 Water heaters of the side-arm type

32.2.10.1 A water temperature of 77.0°C (170.6°F) is considered to be the highest normal value.

32.2.11 Refrigerator defrosters

32.2.11.1 No external surface of a refrigerator defroster shall exceed 100°C (180°F) rise over ambient temperature. See 45.29.

32.2.12 Heat guns

32.2.12.1 The temperature rise of the supporting surface of a heat gun incorporating a built-in stand shall not exceed 125°C (225°F) when tested in accordance with 32.1.1 with the heat gun utilizing its stand with all possible combinations of attachments available for the heat gun.

33 Test of Insulation Resistance and Leakage Current as a Result of Moisture

33.1 A product employing insulation material likely to be adversely affected by moisture under condition of intended use shall be conditioned for 48 hours in moist air having a relative humidity of 88 ±2 percent at a temperature of 32.0 ±2.0°C (89.6 ±3.6°F). After the conditioning:

- a) A cord-connected product rated for a nominal 120-, 208-, or 240-V supply shall comply with the requirement in 31.1 in a repeat leakage-current test, except that the test shall be discontinued when leakage current stabilizes.
- b) A product other than mentioned in (a) shall have an insulation resistance of not less than 50,000 ohms between live parts and interconnected dead metal parts.

33.2 The insulation resistance is to be measured by:

- a) A magneto megohmmeter that has an open circuit output of 500 V,
- b) A voltmeter having an internal resistance of at least 30,000 ohms and using a 250-V d-c circuit, or
- c) Equivalent equipment.

33.3 A product that by design and intended use can be expected to be used outdoors – for example, a stock-tank de-icer, or charcoal ignitor, or heat gun – and a product such as a refrigerator defroster, which may be exposed to wet or moist conditions, when tested after being conditioned as indicated in 33.4 – 33.6:

- a) If a cord-connected product rated for a nominal 120-, 208-, or 240-V supply, shall comply with the requirement in 31.1 in a repeat leakage-current test, except that the test shall be discontinued when leakage current stabilizes.
- b) If a product other than those mentioned in (a), shall have an insulation resistance of not less than 50,000 ohms.
- c) Shall also be capable of withstanding without breakdown for a period of 1 minute, the application of a 60 Hz essentially sinusoidal potential between live parts and interconnected dead-metal parts. The dielectric voltage-withstand test potential shall be 1000 V if the product is rated 250 V or less, and shall be 1000 V plus twice rated voltage if the product is rated more than 250 V.

33.4 After being conditioned as follows, and in the sequence indicated, each of two samples of a charcoal ignitor is to be tested first for leakage current and then dielectric voltage-withstand as indicated in 33.3.

- a) Each sample is to be placed on a horizontal thermally insulated surface and operated at the voltage indicated in 32.1.13 – 32.1.15 for 2-1/2 hours, given time to cool to room temperature, operated for an additional 2-1/2 hours, again given time to cool to room temperature, and so forth, for a total on time of 500 hours.
- b) One unenergized sample is then to be placed in a horizontal position on a platform and subjected for 4 hours to a water spray applied at an angle of 45° from the vertical and adjusted to be equivalent to a beating rain. The second sample, unenergized, is also to be subjected to the spray but, before the spray is started, this sample is to be placed in the position most likely to result in wetting of the electrical insulation.

33.5 After being conditioned as follows, and in the sequence indicated, each of two samples of a refrigerator defroster is to be tested first for leakage current and then dielectric voltage-withstand as indicated in 33.3:

- a) Each sample is to be placed on a horizontal thermally insulated surface and operated continuously for 500 hours at the voltage indicated in 32.1.13 – 32.1.15.
- b) One sample is then to be energized at rated voltage, placed in a horizontal position on a platform, and then subjected for 4 hours to a water spray applied at an angle of 45 degrees from the vertical and adjusted to be equivalent to a beating rain. The second sample is also to be energized at rated voltage and subjected to the spray but, before the spray is started, this sample is to be placed in the position most likely to result in wetting of the electrical insulation.

33.6 Except for a charcoal lighter, one sample of a product that can be expected to be used outdoors is to be mounted as in actual service – the product is to be mounted in any shield or other shelter that the manufacturer provides for use with the product. While so mounted and without being energized the product is to be subjected for 4 hours to a water spray applied at an angle 45° from the vertical and adjusted to be equivalent to a beating rain. After this conditioning and while still mounted, the product is to be tested first for leakage current or for insulation resistance and then dielectric voltage-withstand as indicated in 33.3.

Exception No. 1: A heat gun need not be subjected to the water-spray test described in 33.6 if the dew point test described in 33.7 – 33.9 is performed.

Exception No. 2: A heat gun need not be subjected to the water-spray test described in 33.6 if the marking described in the exception to 45.30 is provided, but shall be subjected to the dew point test described in 33.7 – 33.9.

33.7 A heat gun, as mentioned in the exceptions to 33.6, shall not have a leakage current greater than 2.0 mA after being conditioned as described in 33.8 and 33.9. Following conditioning, a heat gun with a leakage current that exceeds 0.5 mA shall be additionally tested as follows: after a minimum of 10 hours storage at room temperature and humidity, or after 1 hour running on the lowest heat setting, the leakage current shall not exceed 0.5 mA.

33.8 The heat gun is to be conditioned in a cold chamber at $5.0 \pm 2.0^{\circ}\text{C}$ ($41.0 \pm 3.6^{\circ}\text{F}$) for at least 4 hours, then transferred from the cold chamber to a humidity chamber at 88 ± 2 percent relative humidity at $32.0 \pm 2.0^{\circ}\text{C}$ ($89.6 \pm 3.6^{\circ}\text{F}$). The transfer time shall not exceed 1 minute.

33.9 Immediately after being placed in the humidity chamber, the leakage current is to be measured between all exposed conductive surfaces and all gripping surfaces and earth ground with the heat gun connected to the intended branch-circuit supply but not operating. The leakage current shall be continuously monitored until it stabilizes or drops.

33.10 In the case of a warming tray, a volume of hard water solution made as described in 31.10 and in sufficient quantity to cover the product surface to a depth of 5 mm, is to be sponged over the serving surface. The sponging operation is to consist of using the volume of water described above in a simulated cleaning operation with the water being allowed to drain from the edges. At the conclusion of this test, the leakage-current or insulation-resistance and the dielectric voltage-withstand tests described in 33.3 are to be conducted. The leakage current is not to exceed 0.5 mA.

33.11 Except as noted in 33.12, a product that can be expected to be immersed in water for cleaning shall show a leakage current of not more than 0.5 mA and shall be capable of withstanding a potential of 1000 V when tested in accordance with 33.12 – 33.15. The test shall not result in the entrance of water into the interior of the product such that the water might come into contact with uninsulated live parts.

33.12 A product marked to indicate that it is not intended for immersion need not comply with the requirements in 33.11. See 45.19.

33.13 Three samples of the product are to be heated and are then to be immersed immediately in water at a temperature of $10 - 25^{\circ}\text{C}$ ($50 - 77^{\circ}\text{F}$). The immersion is to be complete unless the product is marked to indicate that it is intended for partial immersion only, see 45.19, in which case each product is to be immersed only to the extent indicated. After 1 hour of immersion, the samples are to be removed from the water, dried with a soft cloth to remove all surface moisture, including surface moisture from terminal pins, and the samples are to be tested for leakage current as indicated in 33.3.

33.14 The entire procedure of immersion and leakage-current measurement is to be repeated four times, immediately following which each sample is to be subjected to a 1000-V dielectric voltage-withstand test as described in 34.1. The three samples are to be used for aging tests, and are required to comply with the requirements in 32.1.4 – 32.1.6. If there is an air cavity having electrical components, the three samples are to be disassembled and the internal parts visually examined for the presence of water (33.11). See Table 33.1.

Table 33.1
Immersion tests for appliances intended to be immersed^a

First 5 cycles	Dry initially and throughout conditioning Immerse for 1 hour Dry with cloth Conduct leakage-current test
After 5th cycle	Conduct dielectric voltage-withstand test Operate 240 hours Cool to room temperature Reheat as for normal-temperature test Immerse for 1 hour Conduct leakage-current test Conduct dielectric voltage-withstand test
^a If there is an air cavity housing electrical components in the appliance, disassemble the appliance and examine for water.	

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

33.16 The three samples to be used for the tests described in 33.13 and 33.14 are to be operated, as described in 33.15.

34 Dielectric Voltage-Withstand Test

34.1 A heating appliance shall be capable of withstanding for 1 minute without breakdown a 60 Hz essentially sinusoidal potential applied between live parts and dead parts, with the product at its maximum normal operating temperature. The test potential (rms) shall be as indicated in Table 34.1.

Table 34.1
Dielectric test potential

Appliance	Test potential (rms)
Appliances that involve moist or wet contact directly with persons or animals	2500 V
Appliances that are rated at more than 250 V and do not involve moist or wet contact	1000 V plus twice the voltage rating of the appliance
Appliances that are rated at 250 V or less and do not involve moist or wet contact	1000 V

34.2 To determine whether a product complies with the requirement in 34.1, the product is to be tested by means of a 500 VA or larger-capacity testing transformer, the output voltage of which is essentially sinusoidal and can be varied. The applied potential is to be increased gradually from zero until the required test value is reached, and held at that value for 1 minute. The increase in the applied potential is to be at a uniform rate and as rapid as consistent with its value being correctly indicated by the voltmeter.

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

34.4 An immersion-type heater in which the electrodes make contact with a liquid shall be capable of withstanding successfully, for a period of 1 minute, the application of a potential of 150 percent of the maximum rated voltage of the product across the supply connections, under any condition of intended operation of the product.

35 Mechanical Endurance Test

35.1 If the intended operation of a heating appliance causes movement of the internal wiring, the product shall be capable of operating for 6000 cycles in the intended manner while connected to a supply circuit of the voltage indicated in the Normal Temperature Test, Section 32. If the normal cleaning of a heating appliance causes movement of the internal wiring, the movable part shall be capable of operating successfully for 1000 cycles unenergized in the intended manner indicated in 32.1.2. There shall not be any electrical or mechanical malfunction and, after the test, the product shall comply with the requirements for dielectric voltage-withstand in 34.1 – 34.3.

35.2 In a test to determine whether a heating appliance complies with the requirement in 35.1, any mechanical arrangement may be employed to operate the movable member at a rate of approximately 12 cycles per minute, but, in any case, the cover or movable member is to be so operated that it will reach the actual limits of travel in both directions, each cycle. In the case of a product that has two different stop positions for the hinged cover, 1000 operations out of the total of 6000 are to be made with the cover moved to the wide-open position.

35.3 If flexing or internal electric wiring or uninsulated live parts occurs during installation or inspection of electrical field-wiring connections, see 10.1.1.5, then internal electric wiring or uninsulated live parts are to be flexed 50 cycles under the conditions specified in 35.4.

35.4 Prior to the flexing test required in 35.3, the terminal box or area adjacent to the component termination leads shall be filled with the field-wiring leads, branch-circuit wiring, and the like, as would be encountered in intended use. Flexing of the component leads shall not result in damage to the electrical insulation in the flexing area or disarrangement of the electrical connections that would preclude proper storage of the component connecting leads and there shall be no electrical or mechanical malfunction. After the test, the product shall comply with the requirements for dielectric voltage-withstand in 34.1 – 34.3.

36 Resistance to Impact

36.1 The material of a reservoir, the breakage of which may result in risk of fire or electric shock, shall have such properties as to meet the conditions anticipated in use.

36.2 The reservoir mentioned in the Exception to 11.3 shall withstand the applicable impact test described in 36.3 or 36.6 without cracking, breaking or sustaining other damage that could cause leaking of the liquid it is intended to contain.

36.3 Each of three samples of a product that is hand-supported in normal use is to be subjected to the impact that results from the product being dropped through a distance of 3 feet (914 mm) onto a hardwood surface. Depending upon intended usage, the product is to be dropped so as to strike the floor in the positions most likely to produce adverse results.

36.4 The hardwood surface mentioned in 36.3 is to consist of a layer of nominal 1-inch (25-mm) thick tongue-and-groove oak flooring mounted on two layers of 3/4-inch (19-mm) thick plywood. The hardwood surface assembly is to rest on a concrete floor or the equivalent during the test.

36.5 With reference to 36.3, the test on the product is to be conducted so that each sample strikes the surface in a position different from those of the other two samples. Three individual samples may be employed for the tests, or if the manufacturer so elects, fewer samples may be used in accordance with Figure 36.1. The overall performance is acceptable upon acceptable completion of any one of the procedures represented in the table. If any sample is not acceptable on its first drop in any of three positions, the results of the test are unacceptable.

36.6 A product not normally hand-supported is to be subjected to an impact as required in Table 36.1 on any surface that is susceptible to a blow during normal use. For the top surface the impact is to be produced by dropping a steel sphere, 2 inches (50.8 mm) in diameter and weighing approximately 1.18 lb (535 g), from the height necessary to produce the specified impact as shown in Figure 36.2. The steel sphere shall strike the surface in a location different from those in the other two impacts. For surfaces other than the top of the product, the steel sphere is to be suspended by a cord and allowed to swing as a pendulum, dropping through the vertical distance necessary to cause it to strike the surface with the specified impact as shown in Figure 36.2.

**Figure 36.1
Procedure for Impact Test**

Series Number	Sample Number											
	1	2	3	1	2	3	1	2	3	1	2	3
1	↓ A	N	N	↓ A	N	N	↓ A	N	N	↓ A	N	N
2	↓ A	N	N	↓ A	N	N	↓ U	↓ A	N	↓ U	↓ A	N
3	↓ A	N	N	↓ U	↓ A	N	↓ A	N		↓ U	↓ A	

Arrows indicate sequence of test procedure

A – Acceptable results from drop

U – Unacceptable results from drop

N – No test necessary

SA1162

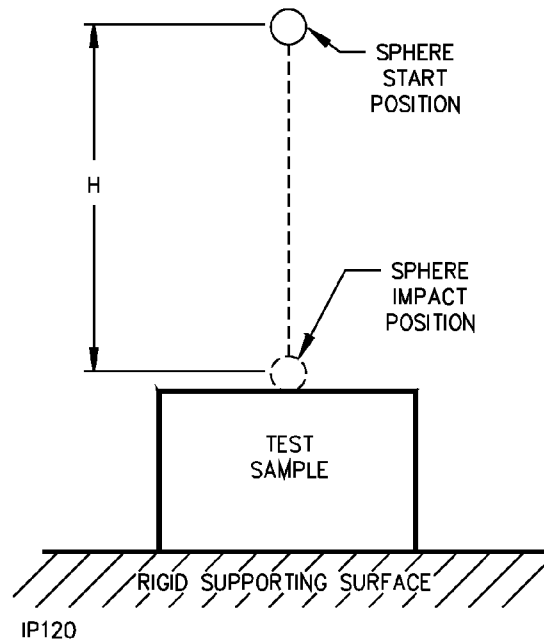
**Table 36.1
Ball impact requirements for a reservoir, ft-lbs (J)**

Easily moved equipment		All other equipment
Counter-supported ^a	Floor-supported ^b	
0.75 (1.02)	5.0 (6.8)	5.0 (6.8)

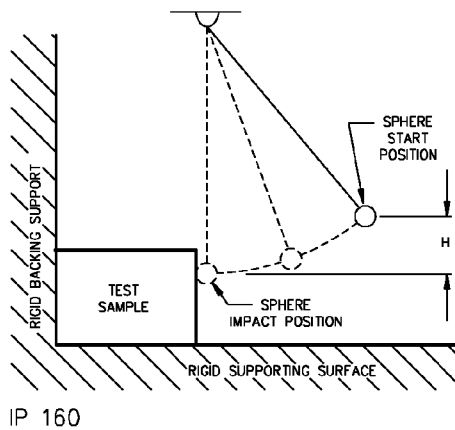
^a Counter-supported equipment is that which is typically supported by a counter, table or bench during the performance of its intended electrically operated functions. Reference is to be made to the specific equipment's Use and Care Literature in establishing the intended electrically operated functions of the equipment.

^b Floor-supported equipment is that which is typically supported by the floor during the performance of its intended electrically operated functions. Reference is to be made to the specific equipment's Use and Care Literature in establishing the intended electrically operated functions of the equipment.

Figure 36.2
Ball Impact Tests



IP120



IP 160

NOTES –

- 1) H in Figure 36.2 indicates the vertical distance the sphere must travel to produce the desired impact.
- 2) For the ball-pendulum impact test the sphere is to contact the test sample when the string is in the vertical position as shown.
- 3) The backing surface is to consist of 3/4-inch (19-mm) plywood over a rigid surface of concrete. An equivalent nonresilient backing surface may be used.

36.7 A product is to be subjected to the applicable impact test described in 36.3 or 36.6 with or without any attachment recommended by the manufacturer, whichever would result in the most severe test.

36.8 After the applicable Impact Test of 36.3 or 36.6 the product shall:

- a) Comply with the Dielectric Voltage-Withstand Test, Section 34,
- b) Comply with the Leakage Current Test requirement of 38.1.4 and,
- c) Have no accessible uninsulated live parts or enamel-insulated wires as determined by the application of the probe shown in Figure 6.2.

37 Overflow Test

37.1 If a heating appliance – such as a vaporizer, sterilizer, or the like – incorporates a reservoir or liquid-storage chamber that is likely to be overfilled in intended use, liquid overflowing from the reservoir or chamber shall not wet uninsulated live parts or enamel-insulated wires, and shall not wet electrical insulation that is likely to be adversely affected by the liquid usually used in the reservoir or chamber.

37.2 To determine whether a product complies with the requirement in 37.1, it is to be tested as follows: water is to be used for the test and is to be poured into the reservoir through an orifice 3/8 inch (9.5 mm) in diameter. The reservoir is to be filled to the level recommended by the manufacturer if such level is plainly marked; otherwise, the reservoir is to be filled to maximum capacity. Additional water, equal to 50 percent of the volume just mentioned, but not more than 1 pint (470 mL), is then to be poured into the reservoir. 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 an insulation-resistance test, a dielectric voltage-withstand test, or both if considered to be appropriate.

38 Abnormal Operation Test

38.1 General

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

38.1.2 To determine whether a risk of fire or electric shock actually exists, a separate burnout or abnormal test is to be conducted with the product operating continuously until the ultimate result has been observed. Unless otherwise indicated, the test is to be conducted with the applied voltage, method of mounting and thermostat connection in accordance with 32.1.13 – 32.1.16 and 32.1.19. In most cases, continuous operation for 7 to 8 hours will be necessary to determine the ultimate result. A cord-connected product is to be placed on white tissue paper on a soft wood surface.

38.1.3 When operated under such abnormal conditions, a product is considered to involve a risk of fire if there is any emission of flame or molten metal, other than drops of melted solder, or if the operation of the product results in the glowing or flaming of combustible material upon which the product may be placed or – in the case of a permanently installed product – may be in proximity to the product as installed.

38.1.4 After having been subjected to an abnormal test, the cord-connected heating appliance is considered to involve a risk of electric shock if the current measured through a 500-ohm resistor between an accessible part and ground is more than 5 mA. The current need not be measured at terminals operating at voltage levels that do not involve a risk of electric shock. In the case of a product utilizing a liquid in its intended operation, the liquid container is to be filled with the hard-water solution described in 31.10 in the intended manner, prior to the current measurement. Liquid need not be added if it is obviously apparent that the product will not hold liquid. Otherwise, water in an amount equal to the capacity of the container is to be poured into the container and the current is to be measured as quickly as possible thereafter.

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

38.2 Specific test conditions

38.2.1 General

38.2.1.1 For most of the common types of heating appliances, standardized abnormal test conditions are given in 38.2.2.1 – 38.2.17.1.

38.2.2 Products with breakable exterior surfaces

38.2.2.1 If a product, such as a warming tray, has an exterior surface of glass, ceramic, or comparably brittle material in or on which the heating element is mounted or that is an essential part of the enclosure of live parts, the material shall be capable of withstanding the stresses likely to be encountered in actual service.

38.2.2.2 Certain specific tests are described in 38.2.3.1 – 38.2.3.3, but other tests may be necessitated by the design or intended operation of the product.

38.2.3 Products with breakable surfaces

38.2.3.1 The glass or ceramic surface shall withstand without cracking or breaking the application of a cloth fully saturated with water – the hard-water solution described in 31.10 – at room temperature, with the product in the fully heated condition. The quantity of water involved shall wet the surface completely.

- a) A cord-connected product rated for a nominal 120-, 208-, or 240-V supply shall comply with the requirement in 31.1 in a repeat leakage-current test, except that the test shall be discontinued when leakage current stabilizes.
- b) A product other than those mentioned in (a) shall have an insulation resistance of not less than 50,000 ohms.

38.2.3.2 The glass or ceramic surface of a warming tray shall withstand without cracking or breaking the impact of a 2-inch (50.8-mm) diameter, 1.18-lb (0.535-kg) steel ball, dropped from a height of 40.5 inches (1.03 m). Four impacts shall be made at different places on the tray.

38.2.3.3 In the case of a product other than a warming tray, the glass or ceramic surface shall withstand without cracking or breaking the impact of a utensil loaded with 4 lb (1.81 kg) of shot and dropped from a height of 6 inches (152 mm). The size and shape of the utensil shall be as appropriate as possible for the product, and ten impacts of the utensil shall be made.

38.2.4 Heat guns

38.2.4.1 Each of three samples of a heat gun shall be energized at rated wattage and set to operate at maximum normal speed. While still operating, each heat gun shall be dropped three times, from a height of 3 ft (0.91 m), onto a concrete surface so that the point of impact is different for each of the three drops. After the third drop the units are to be examined and tested for compliance with the requirements of 38.2.4.2.

Exception No. 1: Compliance with 38.2.4.2 (a), (b), and (d) shall be determined after each drop is completed.

Exception No. 2: The heating element in a hand-supported heat gun shall be so constructed that if the wire is broken at any point there shall be no reduction of electrical spacings below the limits specified in Spacings, Section 25. If broken, no portion of the heating element wire shall be accessible to contact by the 1/4 inch (6.4 mm) diameter probe (Figure 6.4) through any opening in the enclosure, while the heat gun is rotated and moved as intended during normal use.

38.2.4.2 If a sample, after being subjected to the test specified in 38.2.4.1;

- a) Permits the entry of a 1/4-inch (6.4-mm) diameter probe, Figure 6.4, into the enclosure to contact an uninsulated live part,
- b) Is unable to comply with the dielectric voltage-withstand test specified in 34.1,
- c) Experiences circuit interruption by component burnout other than operation of a one-time protective device, or
- d) Has caused the 3-A fuse to ground to open,

the result is not considered to be acceptable. If still in an operating condition, the sample is to be tested in accordance with 38.2.4.3.

38.2.4.3 If a heat gun appears operable following the three drops, it is to be energized for 1 hour or until ultimate results are noted, whichever occurs first. Upon completion of this test, after dropping and operation, compliance with 38.2.4.2 shall be determined for each sample.

38.2.5 Ceramics-baking kilns and ovens

38.2.5.1 A kiln or oven which bears the warning marking described in 45.17 is to be operated until temperatures have become constant.

38.2.6 Charcoal ignitors

38.2.6.1 Without adding charcoal, the operation of the sample used in the normal-temperature test is to be continued for a total of 7 hours. During the test, the grounding means provided by a 3-conductor cord is to be disconnected and the ignitor sheath is to be connected to ground through a 3-A fuse. Rupture of the sheath, opening of the fuse, or dielectric breakdown when the product is tested in accordance with 34.1 and 34.2 indicates that the ignitor is not acceptable.

38.2.6.2 An ignitor is to be operated while supported on its integral stand on a softwood surface covered with two layers of white tissue paper.

38.2.6.3 There shall be no exposed live parts as a result of the following tests. The sheaths of charcoal or log lighters that have been subjected to the following tests shall not rupture or result in a dielectric breakdown when tested in accordance with 34.1 and 34.2.

a) A previously untested sample of the ignitor or log lighter is to be operated in air until thoroughly heated and is then to be dropped six times from a height of 3 ft (0.91 m) onto a concrete surface while still connected to the power supply. In three drops the sheath is to strike the concrete first, and in three drops the handle is to strike the concrete first.

b) A previously untested sample of the ignitor or log lighter is to be energized and its handle held firmly between two lightly padded surfaces with the heating element in a horizontal plane. A mass of 10 lb (4.54 kg) is to be suspended at the end of the well-heated element for 1 minute. If the element sheath bends because of this force, it shall be straightened to its original position.

38.2.7 Stock-tank de-icers, stock waterers, and the like

38.2.7.1 A device intended for heating in low-temperature air shall be operated dry in air at 25°C (77°F) and in air at minus 23.0 ±3.0°C (minus 9.4 ±5.4°F) while supported on a tissue-paper-covered softwood supporting surface with dry, shredded newspaper placed loosely over the active part of the heating surface or surfaces.

38.2.8 Warming trays

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

38.2.9 Immersion heaters

38.2.9.1 A cord-connected immersion heater is to be operated on a softwood surface covered with two layers of white tissue paper, with the sheath of the element in contact with the paper-covered surface.

38.2.10 Liquid heaters

38.2.10.1 A liquid heater is to be operated dry and with all automatic temperature controls or protective devices shunted out of the circuit, except as noted in 32.1.19.

38.2.11 Ovens

38.2.11.1 A nonautomatic oven is to be operated without any temperature regulation.

38.2.12 Poultry and livestock brooders

38.2.12.1 The brooder is to be tested while supported on a softwood surface covered with two layers of white tissue paper, and mounted in the 90 degree corner described in 32.1.17. The brooder is to be located as close to the supporting surface and to both walls of the corner as its construction will permit, and is to be so oriented that maximum heating on the walls and supporting surface will result.

38.2.13 Solder pots, nonautomatic

38.2.13.1 A nonautomatic solder pot is to be operated continuously until ultimate results are observed, while charged with the commonly used metal or alloy that results in highest temperatures. If the product incorporates a means for adjusting the heat input, this is to be set at the maximum.

38.2.14 Soldering irons

38.2.14.1 A soldering iron that does not incorporate a momentary-contact switch is to be operated on its stand until ultimate results are obtained.

38.2.15 Hot plates

38.2.15.1 A hot plate is to be operated continuously with each heating unit covered with a cast-iron circular stove plate. The plate to be used with a 6 inch (152 mm) or smaller surface unit is 7 – 8 inches (178 – 203 mm) in diameter and weighs approximately 3 lb (1.36 kg). The plate to be used with a larger surface unit is 10 – 11 inches (254 – 279 mm) in diameter and weighs approximately 7 lb (3.18 kg).

38.2.16 Ceramic products

38.2.16.1 A ceramic liquid heating appliance shall not involve risk of electric shock when operated as described in 38.2.16.2.

38.2.16.2 The product is to be filled with just enough water – the hard water solution described in 31.10 – to cover the heating element and then operated continuously, without the addition of any more water, until the heating element burns out to open the circuit, except that the time of operation is not to exceed 7 hours. After the product has cooled to room temperature, it is to be half filled with water again and connected to the supply circuit. A risk of electric shock is considered to exist if the current measured through a 500-ohm resistor between the water in the product and ground exceeds 5.0 mA. The current is to be measured again with reversed polarity of the supply circuit.

38.2.16.3 If the product breaks during the heating described in 38.2.16.2, the test is to be discontinued and the product is not to present a risk of fire or electric shock.

38.2.16.4 An insulating washer, gasket, or the like, used as a seal or barrier between uninsulated live parts and the liquid chamber of a liquid heating appliance shall be such that there will not be a leakage current of more than 0.5 mA between liquid in the product and ground after a product has been operated as described in 38.2.16.5.

38.2.16.5 The product is to be operated continuously for 168 hours after having been filled with the liquid usually used in the product. Liquid is to be added from time to time to keep the liquid chamber from becoming less than half full. The product is then to be subjected to a repeated leakage-current test, see 31.1, except that the test is to be discontinued when leakage current stabilizes.

38.2.16.6 An insulating washer or gasket as described in 38.2.16.4 shall show no visible signs of deterioration after being aged for 168 hours in a circulating-air oven at a temperature of $135.0 \pm 1.0^\circ\text{C}$ ($275.0 \pm 1.8^\circ\text{F}$).

38.2.17 Vaporizers of the resistance-wire type

38.2.17.1 A vaporizer of the resistance-wire type is to be operated dry, for not less than 4 hours or until ultimate conditions are obtained. The product is to be completely wrapped in a pad consisting of eight layers of bleached cheesecloth, with the pad in contact with the vaporizer parts, and then placed on a softwood surface.

39 Testing of Component Switches and Control Devices

39.1 Overload

39.1.1 Motor switches

39.1.1.1 A switch or other device that controls a motor employed in a heating appliance, unless previously investigated for the application or unless so interlocked that it will not have to break the locked-rotor motor current, shall be capable of performing acceptably when subjected to an overload test consisting of 50 cycles of operation, making and breaking the locked-rotor current of the motor. There shall be neither electrical nor mechanical malfunction of the device, nor undue burning, pitting, or welding of the contacts.

39.1.1.2 To determine whether a switch or other control device is capable of performing acceptably in the overload test, the product is to be connected to a grounded supply circuit of rated frequency and of voltage in accordance with 32.1.1.13 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 current-rupturing device, if single-pole, is to be located in an 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 test is to be conducted with direct current and exposed dead metal parts are to be so connected as to be positive with respect to a single-pole, current-rupturing device. The device is to be operated at the rate of 10 cycles per minute, except that a faster rate of operation may be employed if agreeable to all concerned. The performance is unacceptable if the fuse in the grounding connection opens during the test.

39.1.2 Automatic controls

39.1.2.1 An automatic control for temperature regulating or temperature limiting shall be capable of performing successfully for 50 cycles of operation, when the heater is connected to a supply circuit having a potential of 120 percent of the voltage specified in 32.1.13. There shall be neither electrical nor mechanical malfunction of the control, nor undue burning, pitting, or welding of the contacts.

39.1.2.2 In tests to determine whether an automatic control complies with the requirements in 39.1.2.1 and 39.1.2.3, 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. If the heater is intended for use on direct current, or on direct current as well as on alternating current, the test is to be conducted with direct current, and the enclosure is to be so connected as to be positive with respect to a single-pole automatic control. The device is to be operated at the rate of 10 cycles per minute, except that a faster rate of operation may be employed if agreeable to all concerned. The performance is unacceptable if the fuse in the grounding connection opens during the test.

39.1.2.3 An automatic control intended for use on direct current, which is so constructed that the starting handle does not stay latched with the timing knob in all of its position settings, thereby resulting in a slow break of the switch contacts upon release of the handle, shall be capable of performing successfully when tested as follows. The switch shall be subjected to 50 cycles of operation at normal load by releasing the handle slowly and, during the test, the metal frame of the product shall be connected to ground through a 3-A fuse to give indication of a flashover, should this occur. This test shall be made following the overload test and preceding the endurance test on the control. See 39.1.2.1 and 39.2.1.1.

39.2 Endurance

39.2.1 Thermostats

39.2.1.1 A thermostat shall be capable of withstanding an endurance test that, except as noted in 39.2.1.3, shall consist of the number of cycles indicated in Table 39.1. Unless it is specified that the test be made without load, the thermostat shall make and break the rated current of 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.

39.2.1.2 With reference to 39.2.1.1 and Table 39.1, thermostats are classified as follows:

- a) A temperature-regulating thermostat is one that functions only to regulate the temperature of the heating appliance 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 appliance 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.

39.2.1.3 For a medicament vaporizer of the resistance-wire type, the endurance test of a thermostat is to consist of 100,000 cycles under load.

Table 39.1
Number of cycles of operation for endurance test

Type of thermostat	Automatically reset thermostat	Manually reset thermostat
Temperature-regulating	A number of cycles equivalent to 1000 hours of normal operation of the heater but not less than 6000 if a household heating appliance, or 30,000 cycles if a commercial appliance. However, the test may be omitted if, with the thermostat short-circuited, no temperatures higher than the limits given in Table 32.1 are attained during the normal-temperature test of the appliance.	To be made the subject of special consideration. ^a
Temperature-limiting	A number of cycles equivalent to 100 hours of operation of the heating appliance under any condition which causes the thermostat to function, or 100,000 cycles, whichever is greater. However, the test may be omitted if, with the thermostat short-circuited, there is no evidence of risk of fire as described in 38.1.1 – 38.1.5 during the continuous abnormal operation of the appliance.	1000 cycles under 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 38.1.1 – 38.1.5 during continuous abnormal operation of the appliance.
Combination temperature-regulating and -limiting	100,000 cycles if, with the thermostat short-circuited, there is evidence of risk of fire as described in 38.1.1 – 38.1.5. 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 consideration.

^a If the operation of the thermostat controls the physical movement of a part of the appliance, the test is to be so arranged that each cycle will involve the complete normal operation of the appliance.

39.3 Limited short circuit

39.3.1 Motor-control devices

39.3.1.1 There shall not be any ignition of cotton surrounding the outer enclosure of the protective device, that, in some cases, will be the enclosure of the motor that it protects, when three samples of a device controlling a 1/2 hp or smaller motor are subjected to short circuits on a circuit limited to 200 A, and when three samples of a device controlling a motor larger than 1/2 hp are subjected to short circuits on a circuit limited to 1000 A.

39.3.1.2 A motor is to be considered to comply with the requirement in 39.3.1.1 if it is equipped with an inherent overheating protector that complies with the requirements for such protectors.

39.3.1.3 For the tests mentioned in 39.3.1.1, the power factor of the test circuit is to be 0.9 – 1.0, and the circuit capacity is to be measured without the device in the circuit.

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

40 Strain Relief Test

40.1 The strain-relief means provided on an attached flexible cord, when tested in accordance with 40.2, shall be capable of withstanding for 1 minute, without displacement, a pull of 35 lbf (156 N) applied to the cord, with the connections within the product disconnected.

Exception: The cord on a soldering iron or wood-burning pencil having a mass of not more than 1/2 lb (0.227 kg) exclusive of the cord shall withstand a pull of 20 lbf (89 N).

40.2 The strain relief means provided on leads as mentioned in the Exception to 10.1.1.5 when tested in accordance with 40.3, shall be capable of withstanding for 1 minute without displacement a pull of 5 lbf (22 N) applied to the leads with connections at the termination disconnected.

40.3 The specified force is to be applied to the cord or leads, and the product so supported 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 sufficient movement of the cord or leads, to indicate that stress on the connections would have resulted.

40A Push-Back Relief Test

Added 40A effective July 16, 1999

40A.1 To determine compliance with 10.2.2.3, a product shall be tested in accordance with 40A.2 without occurrence of any of the following conditions:

- a) The supply cord is subjected to mechanical damage;
- b) The supply cord is exposed to a temperature higher than that for which it is rated;
- c) Spacings, such as to a metal strain-relief clamp, are reduced below the minimum required values; or
- d) Internal connections or components are damaged.

40A.2 The supply cord is to be held 1 inch (25.4 mm) from the point where the cord emerges from the product or cord bushing, when provided, and is then to be pushed back into the product. The cord is to be pushed back into the product in 1 inch (25.4 mm) increments until the cord buckles or the force to push the cord into the product exceeds 6 pounds-force (26.7 N). The supply cord within the product is to be manipulated to determine compliance with 40A.1.

41 Test for Permanence of Cord Tag for Outdoor-Use Heating Appliances with Power-Supply Cords Less than 6 Feet (1.8 m)

41.1 General

41.1.1 These tests are intended for tags employed with outdoor-use heating appliances requiring the marking of 45.33 with power-supply cords less than 6 ft (1.8 m), other than as mentioned in 45.14.

41.1.2 To determine compliance with 45.34, representative samples that have been subjected to the tests described in 41.1.4 – 41.1.7 shall meet the following requirements:

- a) The tag shall resist tearing for longer than 1/16 inch (1.6 mm) at any point;
- b) The tag shall not separate from the power-supply cord;
- c) There shall be no permanent shrinkage, deformation, cracking, or any other condition that will render the marking on the tag illegible; and
- d) Overlamination shall remain in place and not be torn or otherwise damaged. The printing shall remain legible.

41.1.3 For each type of conditioning mentioned in 41.1.4 – 41.1.6, three samples of the tag applied to the power-supply cord in the intended manner are to be used. If tags are applied by an adhesive, tests are to be conducted no sooner than 25 hours after application of the tag.

41.1.4 Three samples are to be tested as received.

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

41.1.6 Three samples are to be tested within 1 minute after exposure for 72 hours to a humidity of 85 ± 5 percent at $32 \pm 2^\circ\text{C}$ ($89.6 \pm 3.6^\circ\text{F}$).

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41.1.7 Each sample is to consist of a length of power-supply cord to which the tag has been applied. The power-supply cord, with the attachment plug pointing up, is to be held tautly in a vertical plane. A force of 5 lbf (22.2 N) is to be applied for one minute to the upper-most corner of the tag farthest from the power-supply cord, within 1/4 inch (6.4 mm) of the vertical edge of the tag. The force is to be applied vertically downward in a direction parallel to the major axis of the cord. In determining compliance with 41.1.2(d), manipulation is permissible, such as straightening of the tag by hand. To determine compliance with 41.1.2(d), each sample is to be scraped 10 times across printed areas and edges, with a force of approximately 2 lbf (8.9 N), using the edge of a 5/64-inch (2.0-mm) thick steel blade held at a right angle to the test surface.

MANUFACTURING AND PRODUCTION-LINE TESTS

42 Production-Line Dielectric Voltage-Withstand Test

42.1 Each product shall withstand without electrical breakdown, as a routine production-line test, the application of a potential at a frequency within the range of 40 – 70 Hz, between:

- a) The primary wiring, including connected components, and accessible dead metal parts that are likely to become energized, and
- b) Primary wiring and accessible low-voltage (42.4 V peak or less) metal parts, including terminals.

42.2 The production-line test shall be in accordance with either Condition A or B of Table 42.1.

Table 42.1
Production-line test conditions

Appliance rating (V)	Condition A		Condition B	
	Potential (volts)	Time (seconds)	Potential (volts)	Time (seconds)
Up to 250 V	1000	60	1200	1
600 V or less applied in a wet or moist condition directly to persons or animals	2500	60	3000	1
251 – 600 V	$1000 + 2 V^a$	60	$1200 + 2.4 V^a$	1

^a Maximum marked voltage.

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

42.4 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.

42.5 When the product employs a solid-state component that is not relied upon to reduce the risk of 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 tested at the potential specified in Table 42.1. 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.

42.6 The test equipment shall include a transformer having an essentially sinusoidal output, a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manual-reset device to restore the equipment after electrical breakdown or an automatic-reject feature of any unacceptable unit.

42.7 If the output of the test-equipment transformer is less than 500 VA, the equipment shall include a voltmeter in the output circuit to directly indicate the test potential.

42.8 If the output of the test-equipment transformer is 500 VA or larger, the test potential may be indicated by a voltmeter in the primary circuit or in a tertiary-winding circuit, by a selector switch marked to indicate the test potential, or, in the case of equipment having a single test-potential output, by a marking in a readily visible location to indicate the test potential. When marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manual-reset switch has been reset following a dielectric breakdown.

42.9 Test equipment, other than that described by 42.6 – 42.8, may be used if found to accomplish the intended factory control.

42.10 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 together and to one terminal of the test equipment, and the second test-equipment terminal is to be connected to the accessible dead metal.

Exception: A product – resistive, high-impedance winding, and the like – having circuitry not subject to excessive secondary-voltage build-up in case of electrical breakdown during the test may be tested:

- a) With a single-pole primary switch, if used, in the off position; or*
- b) With only one side of the primary circuit connected to the test equipment when the primary switching components are in the on position, or when a primary switching component is not used.*

43 Polarization and Grounding Continuity Tests

43.1 Continuity of grounding connection test

43.1.1 As a routine production-line test, each cord-connected appliance having a provision for grounding shall be tested to determine grounding continuity between the grounding blade of the attachment plug and the accessible metal parts of the appliance that are likely to become energized. See 43.3.1.

43.2 Polarization continuity test

43.2.1 As a routine production-line verification, each cord-connected heating appliance provided with a 2-wire polarized or 3-wire grounding attachment plug shall be examined or tested for electrical continuity between the ungrounded circuit supply conductor of the attachment plug (see Figure 10.1 for attachment plug blade connections) and all components intended to be connected to the ungrounded conductor. If the continuity cannot be readily determined by visual inspection and component checking, an electrical continuity test is to be conducted. See 43.3.1.

43.3 Electrical indicating device

43.3.1 Any indicating device (an ohmmeter, a battery-and-buzzer combination, or the like) may be used to determine compliance with the continuity requirements in 43.1.1 and 43.2.1.

RATINGS

44 Details

44.1 A heating appliance shall be rated in amperes, volt-amperes, or watts, and also in volts, and may be rated for alternating current only. The rating shall include the number of phases if the product is constructed for use on a polyphase circuit, and shall include the frequency if necessary because of motors, relay coils, or other control devices. The voltage rating shall be in accordance with any appropriate single voltage or range of voltages, such as 100 – 120, 208, 220 – 240, 254 – 277, 416, 440 – 480, 550, 575, and 600.

44.2 A heating appliance having provision for permanent connection to the electrical supply and incorporating a motor load of more than 1/20 hp shall also be marked in accordance with 45.2.

44.3 When a heating appliance includes an attachment-plug receptacle that is not intended as a disconnecting means for any part of the product or necessary accessory, and that serves as a general-use outlet, the added load that the receptacle imposes on the product and its supply connections – not less than 660 W or 6 A – shall be taken into consideration in determining the electrical rating of the product.

44.3 revised November 17, 1997

44.4 A liquid-heating appliance in which live parts are in contact with the liquid shall be rated for alternating current only.

44.5 The rating of a liquid-heating appliance of the immersed-electrode type may include a current or wattage range to indicate the general variations that may be anticipated when the product is used with water of different conductivity.

MARKINGS

45 Details

45.1 A heating appliance shall be permanently marked where it will be plainly visible – after installation in the case of a permanently connected product – with the manufacturer's name, trade name, trademark, or other descriptive marking by which the organization responsible for the product may be identified, the catalog number or the equivalent, and the electrical ratings. A product intended for use on alternating current only or direct current only shall be so marked.

45.2 A heating appliance constructed as described in 44.2 shall also be marked with the motor load in amperes and volts.

45.3 If a manufacturer produces or assembles heating appliances at more than one factory, each finished product shall have a distinctive marking – which may be in code – by which it may be identified as the product of a particular factory.

45.4 Each individual heating element or unit that is a part of a heating appliance and that is replaceable in the field shall be plainly marked with its electrical ratings in amperes or watts, and also in volts, or with the manufacturer's part number.

45.5 A heating appliance whose acceptable performance depends upon its proper location or position shall be marked – such as "top " and "bottom " – to indicate the way in which it is to be installed or used, unless such position is obvious.

45.6 If the design of a heating appliance contemplates disassembly by means of a tool for the purpose of cleaning or similar servicing by the user, including replacement of a thermal cutoff, and, if such disassembly involves the exposure of persons to unintentional contact with any usually enclosed or protected live part, the product shall be plainly marked with a warning that such servicing should be done only while the product is disconnected from the supply circuit. See also 6.17.

45.7 If any point within a terminal box or wiring compartment of a permanently connected heating appliance in which field-installed conductors are intended to be connected, including such conductors themselves, attains a temperature higher than 60°C (140°F) during the normal-temperature test, the product shall be legibly marked "For supply connections use ___ AWG or larger wires suitable for at least ___°C (___°F)" or with an equivalent statement. The temperature value shall be in accordance with Table 45.1. The wire size need not be included if 14 AWG (0.21 mm²) wire was used during the test. This wording shall be located at or near the point where the supply connections are to be made and shall be clearly visible during installation and examination of the supply-wiring connections.

45.7 revised February 13, 2004

Table 45.1
Temperature for marking

Temperature attained in terminal box or compartment during test	Temperature marking
61 – 75°C (142 – 167°F)	75°C (167°F)
76 – 90°C (169 – 194°F)	90°C (194°F)

45.8 The outlet box provided with an immersion heater intended for use in water shall be marked in accordance with 45.7.

45.9 If a specific spacing between a heating appliance intended to be either permanently connected electrically or fastened in place or located in a dedicated space and an adjacent surface is necessary to limit the temperature to not more than 90°C (194°F) on the latter when the product is operated as intended, the product shall be marked "Do not install closer than ___ inches (or ___ mm) to a (vertical, horizontal, or other) surface." The value of the spacing to be used in the statement shall not be less than that necessary to limit the temperature to not more than 90°C (194°F) on the walls when the product is tested in the corner described in 32.1.17. The statement shall be legible and so located where clearly visible during installation and examination of the supply-wiring connections for products intended to be permanently connected electrically and during and after installation for products intended to be fastened in place or located in a dedicated space.

45.10 A cord-connected heating appliance that is required to have provision for grounding through the cord and plug in accordance with 26.6 shall be plainly marked "CAUTION" and the following or the equivalent statement, "To provide continued protection against risk of electric shock, connect to properly grounded outlets only."

45.11 Each heating appliance provided with a 2-wire polarized attachment plug shall be provided with the following instructions or the equivalent: "This appliance has a polarized plug (one blade is wider than the other). To reduce the risk of electric shock, this plug is intended to 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 modify the plug in any way."

45.12 A household heating appliance or a commercial soldering station provided with a power-supply cord, attached or detachable, that is less than 4-1/2 ft (1.4 m) in length as described in 10.2.1.1, shall be provided with instructions in accordance with 45.13.

45.13 The instructions required in 45.12 are to include the following information:

- a) A short power-supply cord (or short detachable power-supply cord) is provided to reduce the risks resulting from becoming entangled in or tripping over a longer cord.
- b) Extension cords (or longer detachable power-supply cords) are available and may be used if care is exercised in their use.
- c) If an extension cord (or a long detachable power-supply cord) is used:
 - 1) The marked electrical rating of the detachable power-supply cord or extension cord should be at least as great as the electrical rating of the appliance,
 - 2) If the appliance is of the grounded type, the extension cord should be a grounding-type 3-wire cord, and
 - 3) The longer cord should be arranged so that it will not drape over the countertop or tabletop where it can be tripped over, snagged, or pulled on unintentionally (especially by children).

45.14 A stock-tank water heater, bucket heater, de-icer, and similar type product that is used out of doors and is provided with a power-supply cord, shall be marked with the signal word "WARNING" and the following or the equivalent statement, "Store indoors after winter season. Inspect cord before using. Do not use extension cords. Read all instructions."

45.15 The instructions mentioned in 45.14 shall include a paragraph stating "CAUTION" and the following or equivalent statement, "To provide continued protection against electric shock:

- a) Have a qualified electrician install a properly grounded receptacle outlet, acceptable for outdoor use and protected from snow and rain, immediately adjacent to the location where the heater will be used,
- b) Route the supply cord and locate the heater so as to be protected from damage by live stock,
- c) Do not use extension cords,
- d) Inspect cord before using,
- e) Unplug heater at receptacle outlet when not in use or before removing from tank, and
- f) Store heater indoors after winter season."

45.16 Heating appliances intended for outdoor use with power-supply cords less than 6 ft (1.8 m), other than as mentioned in 45.14, shall be provided with instructions that include 45.13 (b) and (c) and the following information:

- a) Outdoor extension cords should be used with outdoor use products and are surface marked with suffix letter "W-A" and with a tag stating "Suitable for Use with Outdoor Appliances".
- b) A statement indicating that the connection to an extension cord should be kept dry and off the ground.
- c) Store product indoors when not in use – out of the reach of children.
- d) Do not clean this product with a water spray or the like. (This statement may be omitted if the results of a special water hose spray test are acceptable.)

45.17 If the normal-temperature test of a ceramics-baking oven (kiln) is concluded when the internal temperature of the oven has reached a specified value as described in 32.2.2.1, the oven shall have a legible marking, that will be readily visible to the operator after the product has been installed as intended, warning that the power supply to the product should be cut off when the temperature of the interior reaches the specified value.

45.18 An insecticide vaporizer shall be provided with a warning statement, either as a marking on the product itself or included in an instruction booklet packed with the product, cautioning the user that there may be danger if toxic materials are dispensed in a kitchen where there is uncovered food, or in occupied sleeping quarters.

45.19 A heating appliance of the type that can be expected to be immersed in water for cleaning purposes shall be marked "Do not immerse in water" or with an equivalent wording, unless the product has been investigated for water immersion in accordance with 32.1.4 and 33.11. If the product is intended for partial immersion but not for complete immersion, it shall be marked "Do not immerse beyond this point" or with an equivalent wording to show the point beyond that it should not be immersed.

45.20 If the normal-temperature test of a poultry or livestock brooder is conducted with the product mounted at a greater height above the supporting surface than the minimum permitted by its construction, the product shall be marked to indicate that it should be mounted at such height or higher for operation. This marking shall be legible, permanent in character, and so located as to be visible.

45.21 If the guard of a poultry or livestock brooder is removed for shipment, the product shall be marked with a visible, legible marking cautioning against using the product unless the guard is in place.

45.22 A heating appliance that is intended for installation by a nonmetal-enclosed wiring system only shall be marked to indicate that it must be installed with such a wiring system. The marking shall be so located that it will be visible while power-supply connections to the product are being made.

45.23 A product having provision for permanent connection to multiple power supplies shall bear a cautionary marking to indicate that fact. The marking shall be on the outside of the product where visible after installation of the product. The marking shall be made at each point at which a power-supply connection is to be made. The product shall be marked with the word "CAUTION" and the following or the equivalent statement, "This product has more than one power-supply connection point. Disconnect all power supplies before servicing."

45.24 A product that is intended for use with a thermostatically controlled appliance plug shall be permanently marked "Use only (manufacturer) (designation) temperature-controlling plug" or with an equivalent wording.

45.25 A product intended for use with a power source as described in 10.2.1.14 and 10.2.1.15 shall be legibly marked with the following or an equivalent statement, "(Name and model number of the product) for use with power source number ____." A power source intended for use with a product as described in 10.2.1.14 and 10.2.1.15 shall be legibly marked with the following or an equivalent statement, "Power source for use with only (name and model number of the product)."

45.26 If required overcurrent protective devices or contactors are provided as a separate assembly, see 17.7 and 24.6, the product shall be marked to indicate that it is to be used only with this separate assembly.

45.27 A drying heater that is intended for paint drying in auto repair and paint shops shall be permanently marked with the following statement, "DANGER – To reduce the risk of explosion, do not use in paint spray booths or within 10 feet of paint spraying operations." The marking shall be readily visible after the heater is in the position of intended use. This marking or the equivalent shall also appear in the operating and direction-for-use instructions.

45.28 A product that is to be installed or used in conformity with provisions of the National Electrical Code and where there may be some question to the installer or user, shall be provided with information, which may be in the form of a description marked on or provided with the product, to identify the acceptability of the product for the specific application, purpose, or environment.

45.29 A refrigerator defroster shall be permanently and legibly marked where visible to the user with the word "CAUTION" and the following or the equivalent statement, "To reduce risk of fire, do not operate unattended; use with care on or near plastic surfaces." The word "CAUTION" shall be in uppercase letters not less than 1/8 inch (3.2 mm) high, and the remaining letters in the marking shall not be less than 1/16 inch (1.6 mm) high.

45.30 A heat gun shall be marked with the word "WARNING" and the following or the equivalent: "To reduce the risk of fire or electric shock, do not expose this product to rain or moisture. Store indoors. Read instruction manual before using." The marking shall be permanent. The signal word WARNING shall be printed in upper case letters or emphasized to distinguish it from the rest of the text and shall be not less than 3/32 inch (2.4 mm) high. The remainder of the text shall be in letters not less than 1/16 inch (1.6 mm) high if the letters have a contrasting color to the background. Letters that are molded or stamped in a material not having a contrasting background color shall have a height of not less than 3/32 inch (2.4 mm) and raised or lowered depth of not less than 0.020 inch (0.51 mm).

Exception: The marking specified in 45.30 need not be provided if the heat gun is marked "FOR INDOOR USE ONLY" or with an equivalent wording. The marking shall be permanent, in a color contrasting with the background, or if molded or stamped raised or lowered for not less than 0.020 inch (0.51 mm) and in letters no less than 3/32 inch (2.4 mm) high.

45.31 The instruction manual for a heat gun shall include the following or equivalent statements:

- a) "Hidden areas such as behind walls, ceilings, floors, soffit boards and other panels may contain flammable materials that could be ignited by the heat gun when working in these locations. The ignition of these materials may not be readily apparent and could result in property damage and injury to persons.

When working in these locations, keep the heat gun moving in a back-and-forth motion. Lingering or pausing in one spot could ignite the panel or the material behind it."

- b) "IMPORTANT SAFETY INSTRUCTIONS.

READ THESE INSTRUCTIONS

WARNING: Extreme care should be taken when stripping paint. The peelings, residue and vapors of paint may contain lead, which is poisonous. Any pre-1977 paint may contain lead and paint applied to homes prior to 1950 is likely to contain lead. Once deposited on surfaces, hand to mouth contact can result in the ingestion of lead. Exposure to even low levels of lead can cause irreversible brain and nervous system damage; young and unborn children are particularly vulnerable.

Before beginning any paint removal process you should determine whether the paint you are removing contains lead. This can be done by your local health department or by a professional who uses a paint analyzer to check the lead content of the paint to be removed. **LEAD-BASED PAINT SHOULD ONLY BE REMOVED BY A PROFESSIONAL AND SHOULD NOT BE REMOVED USING A HEAT GUN.**

Persons removing paint should follow these guidelines:

- 1) Move the work piece outdoors. If this is not possible, keep the work area well ventilated. Open the windows and put an exhaust fan in one of them. Be sure the fan is moving the air from inside to outside.
- 2) Remove or cover any carpets, rugs, furniture, clothing, cooking utensils and air ducts.
- 3) Place drop cloths in the work area to catch any paint chips or peelings. Wear protective clothing such as extra work shirts, overalls and hats.

- 4) Work in one room at a time. Furnishings should be removed or placed in the center of the room and covered. Work areas should be sealed off from the rest of the dwelling by sealing doorways with drop cloths.
- 5) Children, pregnant or potentially pregnant women and nursing mothers should not be present in the work area until the work is done and all clean up is complete.
- 6) Wear a dust respirator mask or a dual filter (dust and fume) respirator mask which has been approved by the Occupational Safety and Health Administration (OSHA), the National Institute of Safety and Health (NIOSH), or the United States Bureau of Mines. These masks and replaceable filters are readily available at major hardware stores. Be sure the mask fits. Beards and facial hair may keep masks from sealing properly. Change filters often. **DISPOSABLE PAPER MASKS ARE NOT ADEQUATE.**
- 7) Use caution when operating the heat gun. Keep the heat gun moving as excessive heat will generate fumes which can be inhaled by the operator.
- 8) Keep food and drink out of the work area. Wash hands, arms and face and rinse mouth before eating or drinking. Do not smoke or chew gum or tobacco in the work area.
- 9) Clean up all removed paint and dust by wet mopping the floors. Use a wet cloth to clean all walls, sills and any other surface where paint or dust is clinging. **DO NOT SWEEP, DRY DUST OR VACUUM.** Use a high phosphate detergent or trisodium phosphate (TSP) to wash and mop areas.
- 10) At the end of each work session put the paint chips and debris in a double plastic bag, close it with tape or twist ties and dispose of properly.
- 11) Remove protective clothing and work shoes in the work area to avoid carrying dust into the rest of the dwelling. Wash work clothes separately. Wipe shoes off with a wet rag that is then washed with the work clothes. Wash hair and body thoroughly with soap and water.

SAVE THESE INSTRUCTIONS"

Exception: The instructions in (b) need not be included in the instruction manual if the heat gun exhaust barrel is so constructed that the heat gun cannot be used to strip paint.

45.32 The marking provided on an electrically energized product that generates steam shall be clearly marked "Not for Space Heating Purposes" or equivalent wording. The product, carton, and literature marking shall not refer to the steam generator as a "boiler".

45.33 A cord-connected outdoor-use heating appliance with a power-supply cord less than 6 ft (1.8 m), other than as mentioned in 45.14, shall be marked: "CAUTION – To reduce the risk of electric shock, keep extension cord connection dry and off the ground", or with an equivalent wording following the word "CAUTION".

45.34 The marking described in 45.33 may be provided on a tag that is permanently attached to the power-supply cord. The tag material and means of attachment to the power-supply cord shall comply with the requirements in Test for Permanence of Cord Tag for Outdoor-Use Heating Appliances with Power-Supply Cords Less than 6 Feet (1.8 m), Section 41. The tag and the printing thereon shall be resistant to water.

45.35 An appliance whose surface temperatures exceed the limits specified in Table 32.2, (see 28.3), shall be marked with the word "CAUTION" and the following or equivalent wording: "Hot Surface. Avoid Contact." The marking shall be located on or adjacent to the surface in question.

45.36 A product that passes water through a filter media before consumption shall be marked, either on the product or in the instruction booklet provided, with the following or equivalent: "The physiological effects of the operation of this appliance, beneficial or otherwise, have not been investigated by _____ (Name, or abbreviation of name, of organization that investigated the appliance for compliance with this Standard)".

45.37 Steam generating products provided with multiple vessels shall be permanently marked adjacent to each steam outlet "DANGER" followed by the following or equivalent: "To Reduce Risk of Explosion, Do Not Interconnect Steam Outlets. A Separate Steam Line Must be Provided for Each Steam Outlet."

46 Instructions

46.1 A product that requires warning, cautionary, or other specific markings as indicated in Markings, Details, Section 45 shall be provided with instructions that duplicate the texts of the required markings and elaborate on the potential risks involved.

Exception: The information specified in 45.1 and 45.2 need not be provided in the instruction booklet.

ELECTRODE-TYPE HEATING APPLIANCES

47 Scope

47.1 These requirements cover portable electrode-type heating appliances intended for household use that are constructed to be employed on nominal 120-V branch circuits. It does not cover electrode-type cosmetic products, except for accessories that may be provided with a heating appliances.

48 General

48.1 In addition to complying with Sections 49 – 55, the products shall comply with all applicable requirements in this Standard.

49 Construction

49.1 A facial sauna attachment for use with a multipurpose electrode-type heating appliance shall include a guard, barrier assembly or an equivalent means to restrict the emission of hot water droplets into the facial area of the product during intended use. The barrier assembly shall be constructed of materials acceptable for and mounted in the manner required for the enclosure of live parts.

49.2 The interposed barrier assembly may consist of two or more layers arranged to provide a baffle effect for all openings.

50 Operation Test

50.1 An electrode-type heating appliance with a facial sauna attachment when subjected to the operation test in 50.2, shall be such that:

- a) There is neither appreciable distortion nor any cracking of any of its parts,
- b) There is no evidence of arcing or tracking over the surface or through insulating material,
- c) There is no evidence of glowing or flaming,
- d) There is no spitting of water in the area where the user's face may be located, and
- e) No more than five fuses are opened by a single product.

50.2 Three samples assembled as for intended use are to be subjected to the following test. A test solution of 4 g/L of sodium chloride (NaCl) in distilled water is to be prepared. The product is to be connected to a 150-V a-c supply through a 20-A time-delay fuse and filled to the intended fill level from a nonconducting container with the test solution. After the current has reduced to an average value of less than 20 percent of rated current, the unit is to remain connected to the supply for an additional 10 minutes. Without emptying or cleaning, the unit is then to be filled to the fill level with distilled, deionized, or tap water having a resistivity greater than 20,000 ohm-centimeters. The cycling is to be continued for a total of 30 complete cycles. After the 30th cycle, the unit is to be de-energized and filled with tap water and then emptied. The preceding steps are then to be repeated nine times starting with the filling using the saline test solution, to obtain 300 cycles of operation. In cases where there is loss of solution salt, sodium chloride is to be added to the distilled, deionized, or tap water so that the operating portion of a cycle does not exceed 300 percent of the time consumed by the initial operating cycle. If the fuse blows at any time during the test, the product is to be emptied and filled with tap water, allowed to stand for 5 seconds and then emptied. The unit is then to be filled with the test solution and the test continued. In each filling care is to be taken to fill only to the recommended fill level and not to overfill the samples.

50.3 An electrode-type heating appliance other than mentioned in 50.1 and 51.1, when subjected to the operation test in 50.4, shall be such that:

- a) There is neither distortion nor any cracking of any of its parts,
- b) There is no evidence of arcing or tracking over the surface or through insulating material,
- c) There is no evidence of glowing or flaming,
- d) There is no continuous spitting of water beyond the outer perimeter of the product, and
- e) Not more than three fuses are opened by a single product.

50.4 Three samples are to be subjected to the test indicated in 50.2 except that the test solution is to be 3 g/L of sodium chloride in distilled water.

51 Vaporizer-Operation Test

51.1 An electrode-type vaporizer when subjected to the operation test in 51.2 shall be such that:

- a) There is neither appreciable distortion nor any cracking of any of its parts,
- b) There is no evidence of arcing or tracking over the surface or through insulating material,
- c) There is no evidence of glowing or flaming,
- d) There is no continuous spitting of water more than 6 inches (152 mm) from the outer perimeter of the vaporizer when measured on the supporting surface, and
- e) Not more than three fuses are opened by a single product.

51.2 Three samples are to be subjected to the following test. A test solution of 2 g/L of sodium chloride (NaCl) in distilled water is to be prepared. The product is to be connected to a 150-V a-c supply through a 20-A time-delay fuse and filled to the intended level from a nonconducting container with the test solution. After the current has reduced to an average value of less than 20 percent of rated current, the unit is to remain connected to the supply for an additional hour. Without emptying or cleaning, the unit is then to be filled to the filled level with distilled, deionized, or tap water having a resistivity greater than 20,000 ohm-centimeters. The cycling is to be continued for a total of five complete cycles. After the fifth cycle, the unit is to be de-energized. The electrode unit is then to be removed and immersed up to the full mark in tap water. The upper and lower openings are to be covered and the unit inverted once. The electrode unit is then to be righted and the water allowed to drain through the lower hole. The reservoir is to be rinsed thoroughly with tap water. The electrode unit is to be reinserted and the unit refilled with the sodium chloride solution. This procedure is to be repeated nine times for a total of 50 operating cycles. If the fuse opens at any time during the test, the electrode unit and reservoir are to be rinsed as described above and the product refilled with the sodium chloride solution.

52 Leakage Current Test

52.1 A vaporizer shall be constructed so that when filled to the "filled" level mark with a hard water solution of 0.5 gram of calcium sulfate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) per liter of distilled water, the leakage current measured at any point that can be contacted by the articulate probe in Figure 6.2 does not exceed 0.5 mA. The vaporizer shall be operated normally (assembled) or with the electrode unit or any part such as a fill cap moved to any possible position that can be maintained unattended and still provide for normal operation. The fill cap may be left in its normal (closed) position if marked in accordance with 54.2(c). See 52.9.

52.2 A vaporizer shall not present a risk of electric shock when the electrode unit and its housing (if removable without the use of tools) is partially removed from the hard-water solution. The vaporizer shall be considered to involve a risk of electric shock if the current from any point, including the hard solution, when contacted by the probe specified in 52.1 is more than 5 mA, when measured through a 500-ohm resistor. The current shall be measured with the vaporizer connected to the normal supply circuit. The current shall be measured again with reverse polarity of the supply circuit.

52.3 During the test covered in 52.2, a reservoir, the material of which has not been found acceptable for the intended application, is to be disregarded and the measurement taken directly from the hard-water solution by locating the electrode unit in any position of operation, or whatever other means may be necessary.

52.4 An electrode-type appliance other than a vaporizer shall be constructed so that with the appliance assembled and filled for use in its intended manner, there are no openings in the enclosure or guard which would permit contact with the energized water by use of:

- a) The articulate probe illustrated in Figure 6.2 or the rod illustrated in Figure 6.4 and
- b) As judged by the requirements in 6.13 and 6.15.

52.5 The leakage current available from accessible surfaces (including those moistened by the liquid) of an electrode type heating appliance other than a vaporizer under any intended condition of operation shall not be greater than 0.5 mA when the unit is operated with a hard-water solution made as described in 52.1. In the case of a bottle warmer, a bottle completely wrapped in metal foil is to be placed in the product. See 52.9.

52.6 During the tests covered in 52.4, 52.5 and 52.7, a guard or enclosure the material of which has not been found acceptable for the particular application is to be removed.

52.7 An electrode-type appliance other than a vaporizer shall have a leakage current not exceeding 0.5 mA when measured under conditions described in (a) and (b):

a) The water container of an appliance at room temperature is to be filled with a volume of the hard water solution – made as specified in 52.1 – equal to 150 percent of the maximum intended amount recommended by the manufacturer. The leakage current to ground is to be measured with the unit operating while tipped in any direction and at any angle not exceeding 30 degrees from its normal operating position to cause maximum leakage current. The probe employed in the measurement shall be a copper alloy rod with an insulated handle. The rod is to be:

- 1) Sized to represent the probe in Figure 6.2 or 6.4 and
- 2) Applied as determined by 6.13 and 6.15. See 52.9.

b) The test in (a) is to be repeated, except that the appliance is to be mounted in its normal operating position and filled with twice the maximum volume of the specified hard-water solution.

52.8 If the appliance is provided with a polarized attachment plug, the current measured as described in 52.7 shall not exceed 0.5 mA with the plug inserted in the receptacle either in the intended position, or with the polarity reversed.

52.9 During the tests outlined in 52.1 – 52.8:

- a) The supply voltage is to be 120 V, and
- b) The leakage current is to be measured as described in 31.1 – 31.7, except that the leakage current is to be continuously monitored until it stabilizes or decreases.

53 Disassembly and Reassembly Test

53.1 If the instructions involve disassembly of any parts for cleaning, it shall be determined that the unit is unlikely to be reassembled in a manner that will result in a risk of fire, electric shock, or injury to persons.

54 Markings

54.1 An electrode-type vaporizer employing Type STP-1, SP-1, SPT-2, or SP-2 18 AWG (0.82 mm²) supply cord shall have a permanent warning marking consisting of the word "CAUTION " and the following or equivalent statement, "This unit's supply cord may overheat and involve a risk of fire unless cord is unraveled in use."

54.1 revised February 13, 2004

54.2 The product shall be marked with the following:

- a) A filled level marking that can easily be compared to the actual water level during filling, or if other than a vaporizer, with instructions for the use of an integral measuring container or other measuring means for filling. If the measuring container is not integral with the product, the amount shall be expressed in standard measurements in addition to the use of any measuring container provided.
- b) Instructions for filling, cleaning, and rinsing the unit and any instructions for additives to be used.
- c) The word "CAUTION " and the following or equivalent statement, "To provide continued protection against the risk of electric shock:
 - 1) Disconnect the supply cord before filling, rinsing, or cleaning.
 - 2) Do not fill above the filled level mark " (or (2) "Do not fill with more than ___ cups of water ").

In case of a fill cap mentioned in 52.1, the marking shall appear at the fill opening.

54.3 An electrode-type heating appliance employed for warming or cooking foods – such as bottle warmers, egg cookers, and the like – shall be marked with word "CAUTION " and the following or equivalent statement, "For protection against the risk of electric shock, do not put metal containers or utensils in this appliance."

54.4 A vaporizer shall be marked with the word "CAUTION " and the following or the equivalent statement, "To provide continued protection against excessive reservoir water temperatures that may cause burns on upsetting unit, follow instructions on filling, cleaning, and rinsing."

54.5 Unless a facial steamer (sauna) attachment meets the requirements of 49.1 and 50.1, it shall be marked with the word "CAUTION " and the following or equivalent statement, "This product may cause burns from spraying of hot water from unit unless rinsed and cleaned in accordance with the instructions."

54.6 Cautionary markings and instructions shall be permanent and legible and shall be located on a part that cannot be removed without impairing the operation of the product.

54.7 Cautionary marking and instructions intended to instruct the operator shall be legible and clearly visible to the operator during use of the product. Other such markings for servicing instructions should be legible and clearly visible when such servicing is being accomplished.

54.8 Markings intended to warn against a risk of injury to persons shall be prefixed by the word "CAUTION" in letters not less than 3/32 inch (2.4 mm) high.

54.9 A marking that is required to be permanent shall be molded, die-stamped, paint-stenciled, stamped or etched on metal, indelibly stamped lettering, or a pressure-sensitive label secured by adhesive that is acceptable for the particular application (see 56.1 – 56.7). Usage, handling, storage, and the like, of the product will be considered in the determination of the permanence of the marking.

55 Operating Instructions

55.1 Operating instructions shall be provided with the product that include the following:

- a) Information regarding potential risks of fire, electric shock, or injury to persons that may exist due to use of the product. The instructions shall caution the user to place the product and connected cord so that the product is not likely to be upset.
- b) Information regarding the potential risks of electric shock due to overfilling or cleaning the product and removal of the heating element portion of the vaporizer without disconnecting the power-supply cord.
- c) Instructions regarding cleaning the product including any need for disassembly (and reassembly) and any need for the use of additives.

56 Label Adhesion Tests

56.1 Pressure sensitive labels or labels secured by cement or adhesive which have been subjected to the tests outlined in 56.2 – 56.7 shall meet the following conditions:

- a) Each label shall demonstrate good adhesion and the edges shall not be curled.
- b) The label shall resist defacement or removal as demonstrated by scraping across the test panel with a flat metal blade 1/32 inch (0.8 mm) thick, held at a right angle to the test panel.
- c) The printing shall be legible and shall not be defaced by rubbing with thumb or finger pressure.

56.2 For each of the four types of conditioning mentioned in 56.3 and 56.5 – 56.7, three samples of the label are to be applied to the same test surface employed in the intended application. The labels are to be applied to the test surface no less than 24 hours prior to testing.

56.3 Three samples of the labels are to be evaluated as received.

56.4 Evaluation of samples is to be made at the end of each test as indicated in 56.5 – 56.7:

- a) Immediately following removal from each test medium, and
- b) After exposure to room temperature for 24 hours following removal from each test medium.

56.5 Three samples of the labels under test are to be placed in a full-draft circulating-air oven maintained at the temperature indicated in Table 56.1 for 240 hours.

Table 56.1
Oven temperature

Maximum normal operating temperature of surface of applied label °C (°F)	Air oven test temperature °C (°F)
60 (140) or less	87 (189)
80 (176) or less	105 (221)
100 (212) or less	121 (250)
125 (257) or less	150 (302)
150 (302) or less	180 (356)

56.6 Three samples of the labels under test are to be immersed in water at a temperature of $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) for a period of 48 hours.

56.7 If the labels are exposed to unusual conditions in service, such as exposure to medicants, detergents, oils, or the like, three additional samples are to be conditioned as follows. The samples are to be immersed in a solution representative of service use maintained at $23.0 \pm 2.0^{\circ}\text{C}$ ($73.4 \pm 3.6^{\circ}\text{F}$) for 48 hours. For exposure to detergents, the solution is to consist of a mixture of 25 g of a commercial detergent per liter of water.

THERMOSTAT OVERRIDE UNITS

57 General

57.1 In addition to complying with the Temperature Test, Section 58, and the Overload Tests, Section 59, a thermostat override unit shall comply with all applicable requirements in this Standard.

57.2 A resistor used as a source of heat for a thermostat override unit shall not be operated over its marked or designated power rating.

Exception: A wire-wound ceramic resistor may be operated in excess of its marked or designated power rating. See Exception No. 1 to 59.1.

57.3 To determine compliance with 57.2, the input power is to be calculated by $W = V^2/R$, where V equals the supply voltage – or highest voltage of the applicable range of voltages specified in 44.1 if the marked voltage is within one of the voltage ratings indicated in 44.1 – and R is the nominal (marked) resistance minus the marked tolerance. Should no tolerance be marked, a tolerance of plus or minus 20 percent is to be assumed.

57.4 If the circuitry of the thermostat override unit is such that the input to the resistor is a complex waveform, so that the calculated power rating of the resistor does not represent its actual wattage dissipation, power input is to be measured by means of appropriate instruments to obtain the effective power while the unit is connected to the supply voltage specified in 57.3.

58 Temperature Test

58.1 Unless the resistor is securely positioned to prevent it from contacting polymeric enclosure material, the polymeric material shall be acceptable for the maximum temperature measured on the resistor body under intended operating conditions.

Exception: The temperature rating of the polymeric material may be less than the maximum temperature measured on the resistor during the normal temperature test if five samples of the thermostat override unit are operated for 1000 hours with the resistor in contact with or as close as possible to the polymeric enclosure material. There shall be no undue distortion, melting or ignition of the enclosure.

58.2 A resistor is considered to be securely positioned if its mounting means provides a reasonable degree of resistance to shifting or motion during rough handling including dropping three samples, three times each, onto a hardwood surface from a height of 3 ft (0.9 m), and during manipulation of the supply cord in any direction. Suspension of the resistor by only its integral pigtail leads is not considered to be securely positioned unless it can be demonstrated that spacing to the enclosure can be consistently maintained during production.

59 Overload Tests

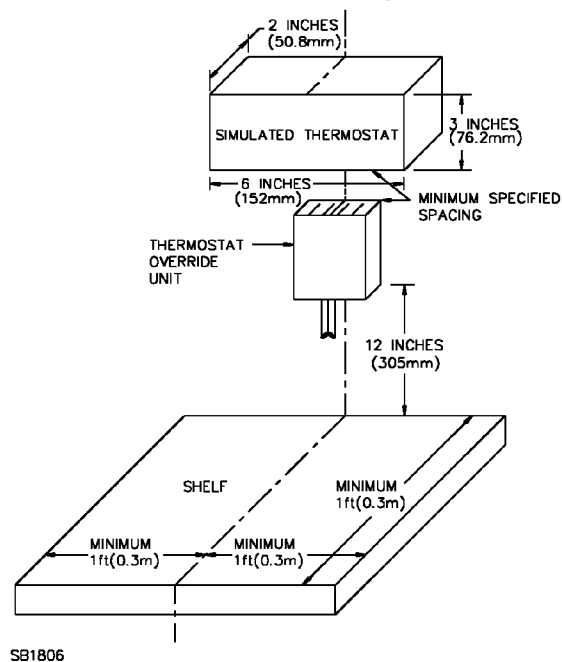
59.1 Units that utilize a resistor as a heat source shall be subjected to the following overload tests.

Exception No. 1: A wire-wound ceramic resistor may be considered for exclusion from 59.2 – 59.5 when operated not in excess of its marked or designated power rating.

Exception No. 2: Other types of resistors may be considered for exclusion from 59.2 – 59.5 if their reliability of performance has been demonstrated for the service conditions encountered in the end-use application – percent wattage dissipation and surface temperature. Evidence that the resistors comply with the applicable sections of Military Specification MIL-R-39008, "Resistors, Fixed, Composition (Insulated), Established Reliability", and have a failure-rate designation "R" (failure-rate of 0.01 percent per 1000 hours), would be regarded as demonstration of reliability of performance.

59.2 Five samples of a thermostat override unit, that have been operated for 1000 hours under intended operating conditions, shall each be mounted on a vertical surface that is covered with a double layer of white tissue paper. A horizontal 3/8 inch (9.5 mm) thick, minimum 1 ft (0.3 m) deep and minimum 2 ft (0.6 m) wide plywood surface is to be mounted 12 inches (305 mm) below the thermostat override unit to simulate mounting directly above a bookcase or desk. The horizontal 3/8 inch (9.5 mm) plywood is to be covered with a double layer of cheesecloth. A 3 by 2 by 6 inches (76 by 51 by 152 mm) box simulating a room thermostat enclosure, constructed of 3/8 inch thick plywood, covered with a double layer of cheesecloth is to be mounted above the thermostat override unit at the minimum distance recommended in the installation instructions. The longest dimension of the box is to be parallel with the top of the thermostat override unit enclosure. If no minimum spacing is indicated, the thermostat override unit shall be mounted as close as possible to the simulated thermostat test box, see Figure 59.1 for details.

Figure 59.1
Overload test setup



59.3 Starting at rated power dissipation, the voltage applied to the thermostat override unit shall be increased at 1-minute intervals to cause the wattage dissipation to increase in steps of 1, 2, 3, 4, 5, and so forth, times the wattage rating of the resistor. Operation shall be continued until the resistor opens.

59.4 As a result of the test, there shall be no melting or ignition of the unit enclosure, nor emission of fire, sparks, flaming material, or molten metal from the unit enclosure, and no glowing or burning of the wood, cheesecloth or tissue paper.

59.5 If acceptable results are obtained during test of the five preconditioned samples, an additional ten "as-received" samples shall be tested. The results shall be considered acceptable if all ten "as-received" samples also comply with 59.4.

SUPPLEMENT SA - ELECTRIC HEATER GUNS FOR GOVERNMENT USE

INTRODUCTION

SA1 Scope

Section SA1 added November 14, 2002

SA1.1 These requirements cover gun-type 120 Vac at 60 Hz electrical heaters intended for use in US Government applications. Typically the heater guns are used to thaw or dry out equipment or to shrink insulating tubing associated with electrical applications. The heater guns are provided in any one of three heat ranges and are identified as Type 1, 2, or 3 as described in Table SA10.1. Government-use heater guns shall comply with the applicable requirements of the preceding sections of this Standard, except as modified or added to by the requirements in this supplement.

CONSTRUCTION

SA2 Switches

Section SA2 added November 14, 2002

SA2.1 A heater gun shall be provided with a three-position switch. The positions of the switch shall be in the following sequence: OFF, ON - FAN, ON - FAN - HEAT and shall be marked in accordance with SA12.2.

SA3 Power-Supply Cord

Section SA3 added November 14, 2002

SA3.1 A heater gun shall be provided with a permanently attached power-supply cord not less than 6 feet (1.8 m) in length.

SA4 Accessories

Section SA4 added November 14, 2002

SA4.1 A heater gun shall be provided with a stand that permits the heated air stream to be directed over a 90° arc. In addition, the heater gun shall be provided with two heat reflectors used to shrink insulating tubing. The reflectors shall provide for the even distribution of heat over at least 1.5 inches (38.1 mm) of length. One reflector shall be for use with tubing up to 0.75 inches (19.1 mm) in diameter and the second for use with tubing greater than 0.75 inches (19.1 mm) to a minimum of 2 inches (50.8 mm) in diameter.

SA5 Heat Regulation

Section SA5 added November 14, 2002

SA5.1 A heater gun shall be equipped with an air regulating system to control the discharge air temperature within the range of temperatures specified in Table SA10.1 for the particular Type (1, 2, or 3) of heater gun.

SA6 Dimensions and Tolerances

Section SA6 added November 14, 2002

SA6.1 A heater gun shall not exceed 12 inches (304.8 mm) in length, 6 inches (152.4 mm) in width, and 16 inches (406.4 mm) in height. The weight of a heater gun shall not exceed 4 pounds (1.8 kg) and shall be capable of single hand operation.

SA7 Finish

Section SA7 added November 14, 2002

SA7.1 The finish of the heater gun shall comply with best commercial practices.

SA8 Workmanship

Section SA8 added November 14, 2002

SA8.1 A heater gun shall be free from sharp edges as determined by the Standard for Test for Sharpness of Edges on Equipment, UL 1439.

REGULATORY REQUIREMENTS**SA9 Recovered Materials**

Section SA9 added November 14, 2002

SA9.1 Recovered materials shall be used to the maximum extent practicable, in accordance with 23.403 of the Federal Acquisition Regulation (FAR).

PERFORMANCE**SA10 Temperature and Air Flow Tests**

Section SA10 added November 14, 2002

SA10.1 General

SA10.1.1 The heater gun shall perform within one of the temperature ranges shown in Table SA10.1 according to its Type classification with a minimum air flow volume of 20 cubic feet per minute. Temperature range is to be determined by compliance with the requirements of SA10.2. Air flow volume is to be determined by compliance with SA10.3.

SA10.2 Temperature Test

SA10.2.1 The test is to be conducted in an ambient temperature of $23.9^{\circ}\text{C} \pm 2.8^{\circ}\text{C}$ ($75^{\circ}\text{F} \pm 5^{\circ}\text{F}$) on each of three representative heater guns. The heater gun is to be operated continuously for a minimum of 5 minutes until stabilized conditions are achieved. During this operation the heater gun is to be supported in the position representing the most severe conditions of use, first without any attachment on the heated air outlet nozzle, and then, when the heater gun is provided with one or more attachments for the heated air outlet, in turn with each attachment in place, as intended. During each of these tests, the plane of the thermocouple grid specified in SA10.2.2 is to be positioned 1 inch (25.4 mm) from the plane of the heated air outlet of:

- a) The heater gun nozzle, or
- b) The attachment nozzle, when provided.

The center of the air stream is to be directed at the center of the grid. Temperatures are to be measured on the grid in one minute intervals for a minimum of 5 minutes after the 5-minute-stabilization period has been achieved.

SA10.2.2 The thermocouple grid assembly is to consist of two pieces of 1/16-inch (1.6-mm) thick glass epoxy board of the configuration and dimensions shown in Figure SA10.1. The two boards are to be separated 1/8-inch (3.2-mm) by one 5-1/4- by 1/4- by 1/8-inch (133- by 6.4- by 3.2-mm) wood spacer at the top and bottom edges. Each spacer is to be secured by four No. 4 - 40 by 3/8-inch counter-sunk flat head machine screws. Each end screw is to be threaded from the face of the assembly into a nut against the rear epoxy board. Each of the middle screws is to be located approximately 1-1/2 inches (38.1 mm) from the nearest longer edge of the board and threaded from the face into a stand-off leg of a sheet aluminum back plate. The 5-1/2 by 3-1/4 inch (140 by 83 mm) stand-off back plate is to consist of sheet aluminum that is 0.05 inch (1.3 mm) thick, having a minimum 7/16-inch (11.1-mm) wide integral stand-off leg formed at each corner by means of an extension of the metal being bent in two successive 90-degree angles to cause the back plate to stand away from the rear epoxy board a distance of 1/4 inch. The back plate is to be secured to the center 5-1/2 by 3-1/4 inch section of the board. The board assembly is to be provided with 53 No. 30 AWG (0.05 mm^2) thermocouples. The thermocouples are to be located on the grid spaced as shown in Figure SA10.1. The thermocouples are to be passed through the two thicknesses of glass epoxy board, and the thermocouple junction is to be cemented to the face of the board using epoxy cement, as shown in Figure SA10.2.

SA10.2.3 A heater gun complies with the temperature range requirements when all measurements are within the temperature range specified for the Type Class of the heater gun being tested.

SA10.3 Air Flow Test

SA10.3.1 The test is to be conducted in an ambient temperature of $23.9^{\circ}\text{C} \pm 2.8^{\circ}\text{C}$ ($75^{\circ}\text{F} \pm 5^{\circ}\text{F}$). The switch is to be in the ON-FAN position (without heat). The air flow volume is to be measured using an instrument such as a rotating vane, air velocity transducer, velometer, manometer, pitot-static tube, or any other device intended for the purpose of directly or indirectly measuring air flow volume. The accuracy of the instrument shall not exceed +/- 5 percent over the desired range. Air flow volume is to be measured first without any attachment on the air outlet nozzle, and then, when the heater gun is provided with one or more attachments for the air outlet, in turn with each attachment in place, as intended. A minimum of five measurements shall be made on each of three representative heater guns.

SA10.3.2 Some of the instruments referenced in SA10.3.1 require test set-ups comprised of air chambers, ducts, air nozzles, thermometers, barometers, and similar components for measuring air flow volume. These set-ups all require the calculations, measurements, or both for static-pressure, dry-bulb and wet-bulb temperature of the air, pressure drop, ratio of air densities, flow areas, and air flow volume. For a detailed analysis of air flow measurements, see American National Standard, Laboratory Methods of Testing Fans for Rating, ANSI/AMCA 210-85/ASHRAE 51. It is recommended that rotating vane type equipment, or similar equipment, be used in the air flow volume measurements that directly and accurately measure air flow volume without the necessity for test chambers and calculations.

SA10.3.3 A heater gun complies with the minimum air flow volume requirement when all measurements exceed the minimum air flow volume of 20 cfm.

Table SA10.1
Temperature ranges

Type	1	2	3
Heat range, °C (°F)	148.9 – 260 (300 – 500)	260 – 398.9 (500 – 750)	398.9 – 537.8 (750 – 1000)

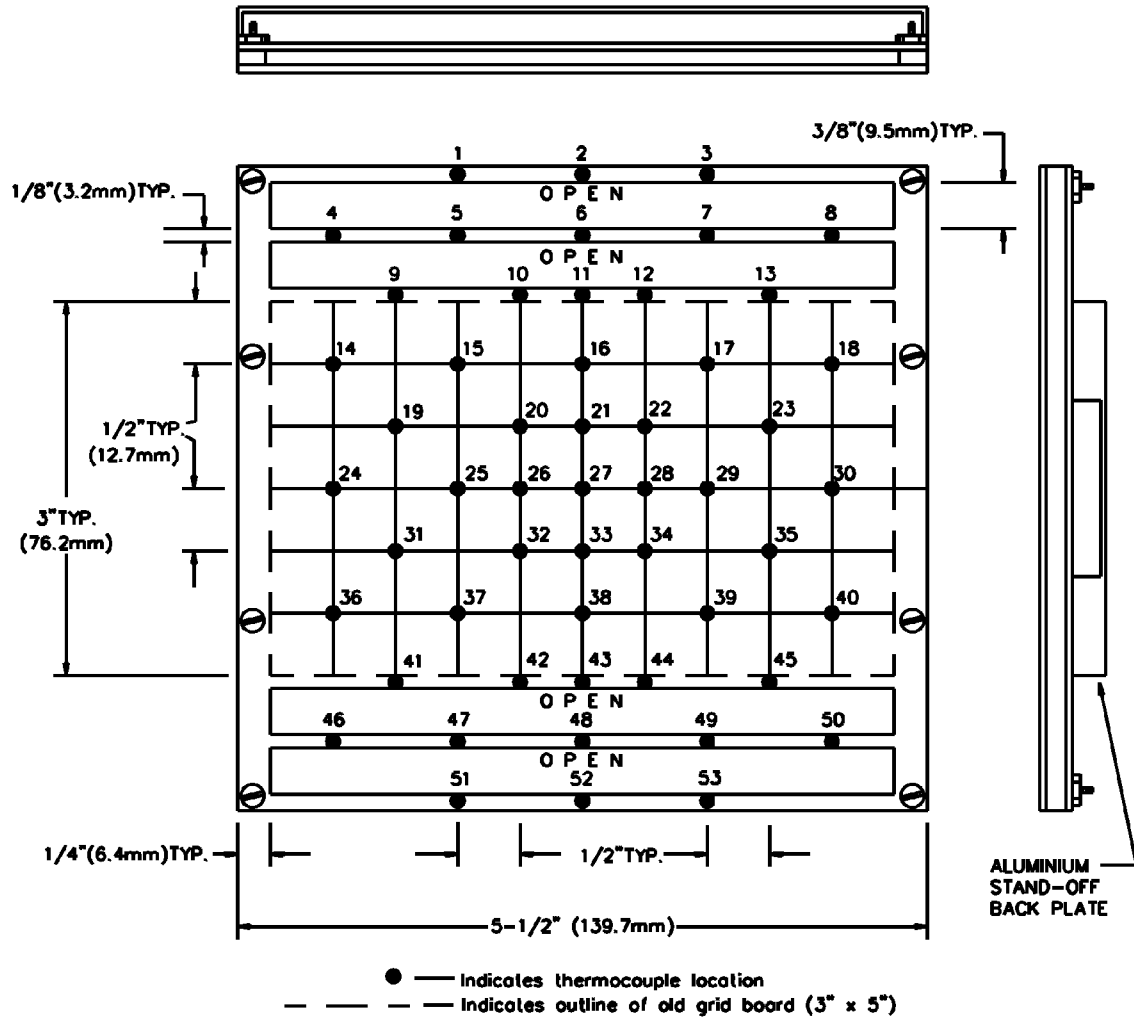
RATINGS

SA11 Details

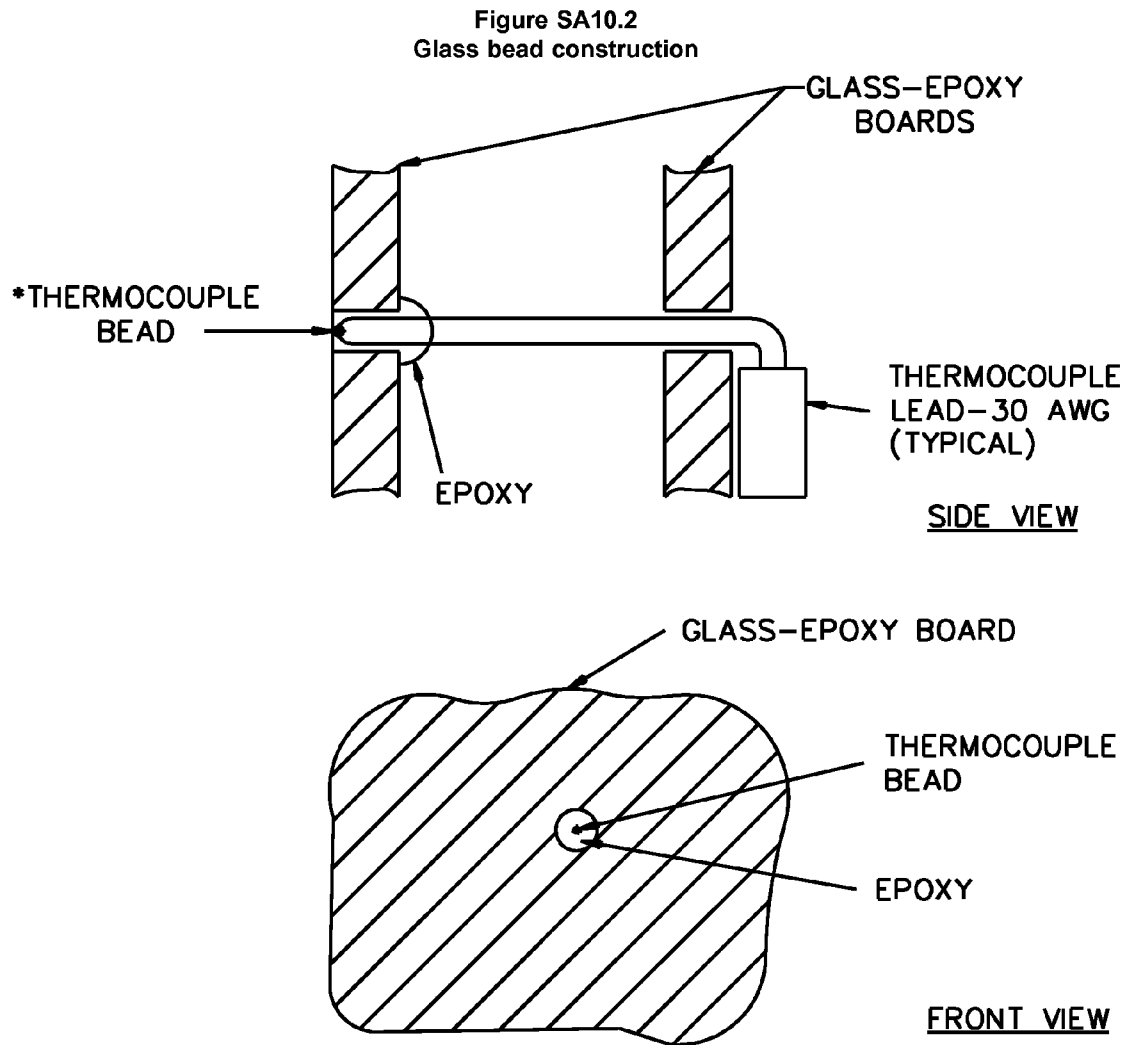
Section SA11 added November 14, 2002

SA11.1 A heater gun shall operate on standard voltage of 120 Vac at 60 Hz.

Figure SA10.1
Spacings on thermocouple grid



S2698



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

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MARKINGS

SA12 Details

Section SA12 added November 14, 2002

12.1 In addition to the marking requirements of UL 499, the heater gun shall be marked with the statement, in letters not less than 3/32 inch (2.4 mm) high in a contrasting color to the background, "Design Classified by Underwriters Laboratories Inc." to meet the requirements of UL 499 Supplement SA, "Electric Heater Guns For Government Use".

SA12.2 The positions of the switch shall be marked in the following sequence; OFF, ON-FAN, ON-FAN-HEAT in letters not less than 3/32 inch (2.4 mm) high in a contrasting color to the background.

PROCUREMENT

SA13 Government Procurement and Acquisition Notes

Section SA13 added November 14, 2002

SA13.1 Part identification number (PIN)

SA13.1.1 To facilitate the use of this Non-Government Standard (NGS), a Part Identification Number (PIN) procedure is to be used for government purposes and does not constitute a requirement for the government contractor. This PIN includes the NGS number, and a dash number which corresponds to the National Stock Numbers (NSNs) and heat ranges described in Table SA13.1. For example, the PIN for a heater gun in the 148.9 – 260°C range is UL 499SA-001.

SA13.2 Ordering data

SA13.2.1 The contract or order shall require the following:

- a) The temperature heat range Type classification (1, 2, or 3) of the heater gun or the NGS PIN of the heater gun, and
- b) Proof of compliance with the Standard for Electric Heating Appliances, UL 499 and its supplement for Electric Heater Guns for Government Use, Supplement SA.

SA13.3 National Stock Numbers (NSNs)

SA13.3.1 The NSNs listed in Table SA13.1 correspond to this NGS.

**Table SA13.1
NSN/NGS cross reference**

NSN	Heat range °C (°F)	NGS dash #
4940-00-357-1369	148.9 TO 260 (300 TO 500)	001
4940-00-785-1162	148.9 TO 260 (300 TO 500)	001
4940-00-314-9789	148.9 TO 260 (300 TO 500)	001
4940-01-028-7493	260 TO 398.9 (500 TO 750)	002
4940-00-438-1606	398.9 TO 537.8 (750 TO 1000)	003
4940-01-391-7046	398.9 TO 537.8 (750 TO 1000)	003

APPENDIX A

Standards for Components

Standards under which components of the products covered by this standard are evaluated include the following:

Title of Standard – UL Standard Designation

Title of Standard – UL Standard Designation

Attachment Plugs and Receptacles – UL 498
Cord Sets and Power-Supply Cords – UL 817
Enclosures for Electrical Equipment – UL 50
Flexible Cord and Fixture Wire – UL 62
Fuseholders – UL 512
Insulating Materials – General, Systems of – UL 1446
Lampholders, Edison-Base – UL 496
Marking and Labeling Systems – UL 969
Motors, Electric – UL 1004
Motors, Overheating Protection for – UL 2111
Outlet Boxes, Fittings for Conduit and – UL 514B
Outlet Boxes, Flush-Device Boxes, and Covers, Nonmetallic– 514C
Outlet Boxes, Metallic – UL 514A
Polymeric Materials – Long Term Property Evaluations– UL 746B
Polymeric Materials – Short Term Property Evaluations– UL 746A
Polymeric Materials – Use in Electrical Equipment Evaluations – UL 746C
Switches, Special-Use – UL 1054
Tape, Polyvinyl Chloride, Polyethylene, and Rubber-Insulating– UL 510
Temperature-Indicating and -Regulating Devices – UL 873
Thermal Cutoffs for Use in Electrical Appliances and Components– UL 1020
Transformers, Class 2 and Class 3 – UL 1585
Tubing, Extruded Insulating – UL 224
Tubing for Electrical Wiring, Flexible Nonmetallic – UL 3
Wires and Cables, Rubber-Insulated – UL 44
Wires and Cables, Thermoplastic-Insulated – UL 83

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