

UL 499

ISBN 0-7629-0161-6

Electric Heating Appliances



Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

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that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.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 Standard consists of pages dated as shown in the following checklist:

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21-22	July 17, 1998
22A	February 13, 2004
22B	July 17, 1998
23	March 26, 1997
24	February 13, 2004
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88	November 14, 2002
SA1-SA8	November 14, 2002
A1-A2	November 14, 2002

No Text on This Page



MARCH 26, 1997
(Title Page Reprinted: February 13, 2004)



ANSI/UL 499-2004

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UL 499

Standard for Electric Heating Appliances

First Edition – October, 1930
Second Edition – October, 1933
Third Edition – December, 1936
Fourth Edition – May, 1940
Fifth Edition – January, 1949
Sixth Edition – August, 1956
Seventh Edition – June, 1962
Eighth Edition – July, 1968
Ninth Edition – January, 1972
Tenth Edition – December, 1978
Eleventh Edition – June, 1987

Twelfth Edition

March 26, 1997

The most recent designation of ANSI/UL 499 as an American National Standard (ANSI) occurred on January 20, 2004.

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:

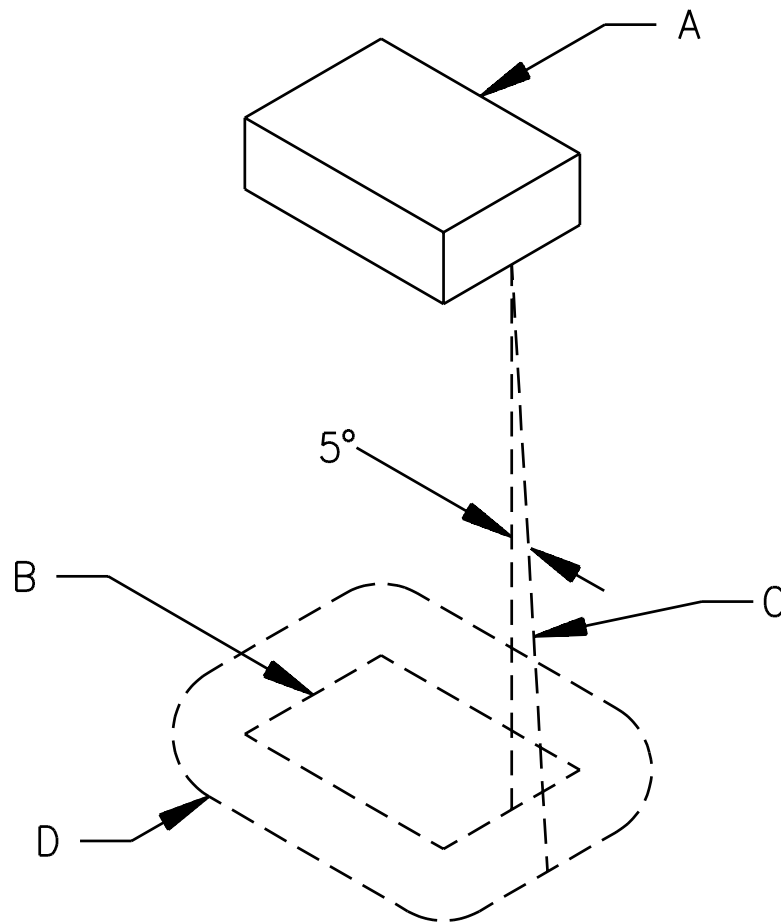
- 1) The structural parts of the motor or of the product provide the equivalent of such a barrier.
- 2) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the product when the motor is energized under each of the following fault 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.

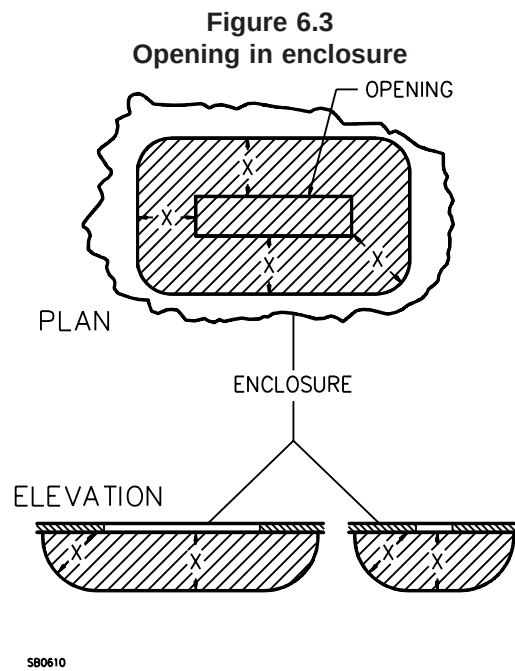
6.13 The criteria for judging a heating appliance enclosure, other than as described in 6.8, are given in 6.15 and 6.16 and in the following items and related illustrations:

- 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.

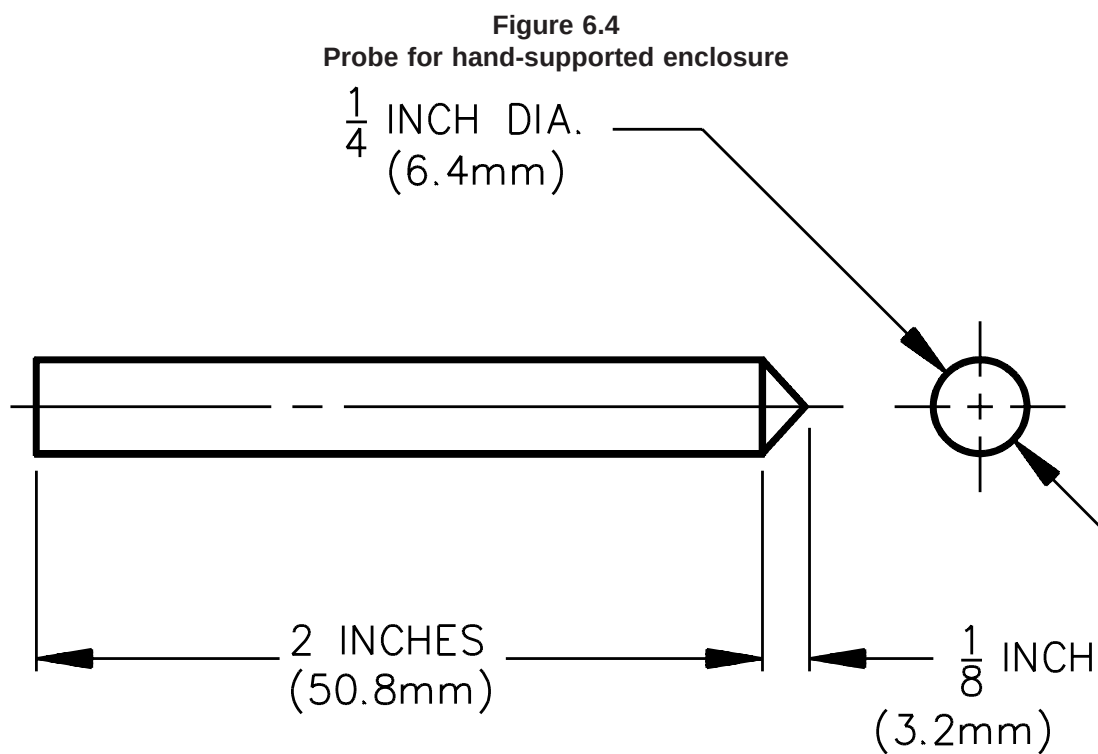
6.14 The opening illustrated in Figure 6.3 is acceptable if, within the enclosure, there is no uninsulated live part or enamel-insulated wire less than X distance from the perimeter of the opening, as well as within the volume generated by projecting the perimeter X distance perpendicular to its plane. 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.



proportions exaggerated for clarity



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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.

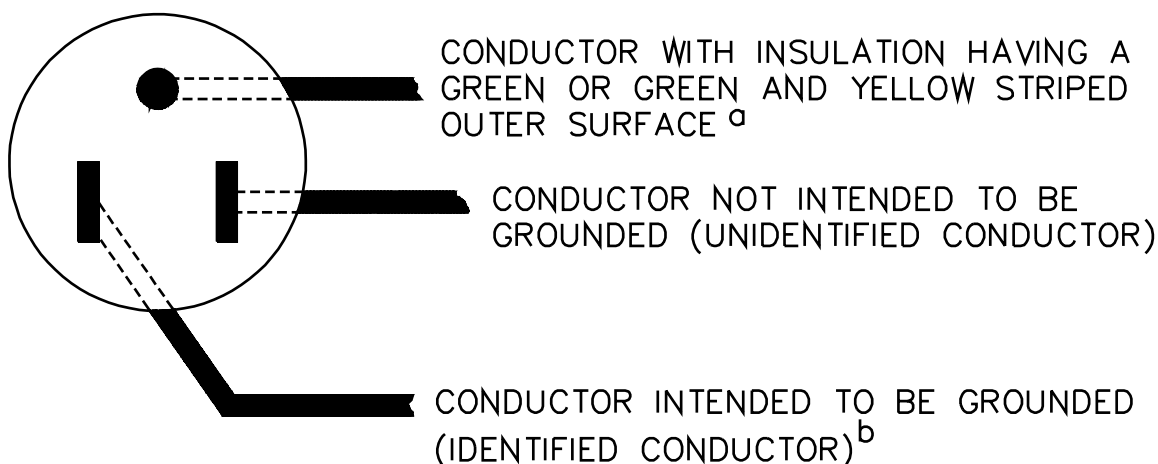
10.2.1.4 The attachment plug of the power-supply cord of an appliance provided with a 15- or 20-ampere general-use receptacle shall be of the 3-wire grounding type. The attachment plug of the power-supply cord of an appliance provided with either a manually operated, line-connected, single pole switch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

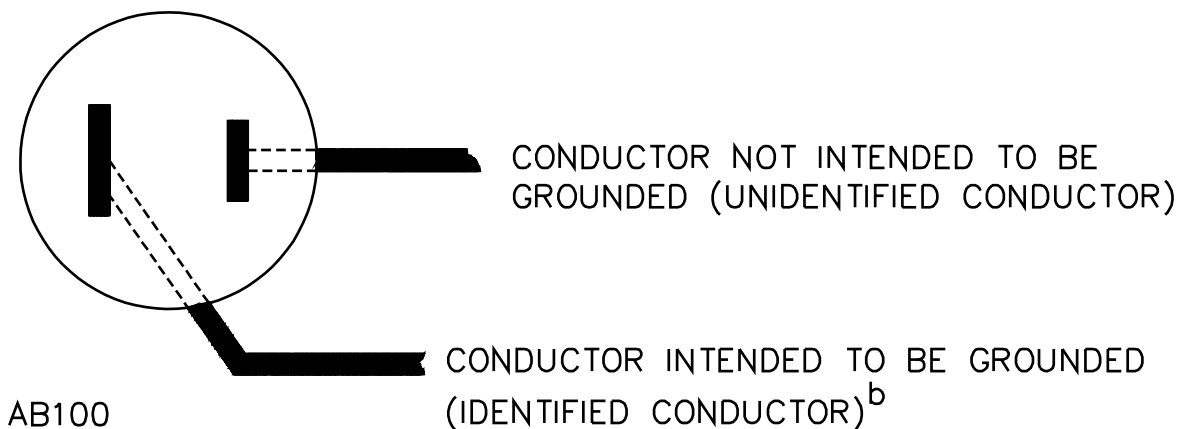
Figure 10.1
Connection to attachment plugs

Figure 10.1 revised July 17, 1998

CONNECTIONS OF CORD CONDUCTORS TO GROUNDING – TYPE
 ATTACHMENT PLUG (FACE OF PLUG REPRESENTED)



CONNECTIONS OF CORD CONDUCTORS TO POLARIZED
 ATTACHMENT PLUG (FACE OF PLUG REPRESENTED)



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.

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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
	C ^b	Solid white or gray	Solid color other than white or gray
Color of insulation on individual conductors	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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