

UL 1278

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Movable and Wall- or
Ceiling-Hung Electric Room
Heaters

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Movable and Wall- or Ceiling-Hung Electric Room Heaters, UL 1278

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A change is indicated by a note following the affected item. The note is preceded and followed by an asterisk.

The new requirements are substantially in accordance with UL's Bulletin(s) on this subject dated July 6, 1998, May 28, 1999, and February 29, 2000. The bulletin(s) is now obsolete and may be discarded.

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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 movable and wall- or ceiling-hung electric room-heating equipment rated 600 volts or less to be employed in ordinary locations in accordance with the National Electrical Code, ANSI/NFPA 70.

1.2 These requirements do not cover fixed heaters, location-dedicated heaters, baseboard heaters, duct heaters, central-heating furnaces, fan-coil units, panel- or cable-type radiant-heating equipment, electric boilers, or any other electric heating equipment or appliances that are covered in or as a part of separate, individual requirements.

1.3 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

2 General

2.1 General

2.1.1 If the operation of a heater 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 an appliance having immersed electrodes, if the electrolysis of water may result in the accumulation of oxygen and hydrogen. The appliance is not acceptable unless its strength is such that it will withstand any risk of explosion that may be involved.

2.2 Terminology

2.2.1 Unless indicated otherwise, all voltage and current values mentioned in this standard are rms.

3 Glossary

3.1 For the purposes of this standard the following definitions apply.

3.2 ANGLE OF CRITICAL BALANCE – The minimum angle through which a heater must be tipped to cause it to tip over due solely to the force of gravity.

3.3 CHARRING WITH CROSSCHECKING – Manifestation of ignition by separation of wood fibers in the direction with the grain and also in the direction across the grain. See Appendix B , Addendum to the Vertical Wall Test.

3.4 COMMERCIAL/INDUSTRIAL HEATER – Any heater that is either:

- a) Rated 2 kilowatts or greater and marked as a commercial/industrial heater in accordance with 64.10,
- b) Rated greater than 250 volts,

- c) A polyphase heater, or
- d) Rated greater than 6 kilowatts.

3.5 CONTROL CIRCUIT – A circuit that carries the electric signals directing the operation of a controller which, in turn, governs power delivered to a motor or other load. A control circuit does not carry the main power current.

3.6 ELEVATED USE LOCATION – A stationary horizontal surface (for example, table, desk or shelf) where a heater is likely to be used if the heater weighs less than 8 lbs (3.6 kg), and:

- a) The heater advertised as being suitable for use at an elevated location in literature or operating instructions furnished with the heater or by marking on the heater or its packaging, or
- b) The overall dimensions of the heater, including any permanently extending handles, grilles, feet or stands do not exceed any one of the following:
 - 1) Total added dimensions of length, height, and depth – 30 inches (76.2 cm).
 - 2) Length – 24 inches (61 cm).
 - 3) Height – 14 inches (35.6 cm).

3.7 FIXED HEATER – A heater that is fastened or otherwise assigned to a specific location, and is permanently wired to the branch circuit.

3.8 FLASH POINT – The minimum temperature of a flammable liquid at which sufficient vapor is given off to form an ignitable mixture with the air near the surface of the liquid or within the vessel used, as determined by appropriate test procedure and apparatus.

3.9 IGNITION – Glowing, emission of embers, or flaming of the materials described in 41.1.9 – 41.1.13. Charring without glowing or without emission of embers is not ignition.

3.10 LINE-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 600 volts, and having circuit characteristics in excess of those of a low-voltage or an isolated-limited-secondary circuit.

3.11 LOCATION-DEDICATED HEATER – A cord-connected heater that is normally placed in one location for usage such as:

- a) Cord-connected wall- or ceiling-mounted heater, or
- b) Freestanding cord-connected heater that exceeds the weight and/or dimension limitations of a movable heater.

3.12 LOW-VOLTAGE (SECONDARY) CIRCUIT – A circuit involving a potential of not more than 30 volts alternating-current, (42.4 volt peak or direct-current), and supplied by a primary battery or by a standard Class 2 transformer, or by a combination of transformer and fixed impedance that, as a unit, complies with all the performance requirements for a Class 2 transformer. A circuit derived from a source of supply classified as a line voltage circuit, using resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low voltage nor an isolated limited secondary circuit.

3.13 MOVABLE HEATER – A freestanding cord and plug connected heater that does not exceed 65 pounds (29.4 kg) and has no dimension greater than 8 feet (2.4 m).

3.14 TEMPERATURE CONTROLS – Devices that respond with a change in temperature (thermostatic devices) may be one of the following types:

- a) Regulating – Functions only to regulate the temperature of the heater under intended conditions of use, and whose malfunction would not result in a risk of fire.
- b) Limiting – Functions only under conditions that produce abnormal temperatures. The malfunction of such a device will result in a risk of fire.
- c) Auxiliary – Thermostatic device other than of the regulating or limiting type.

3.15 VISIBLY GLOWING HEATING ELEMENT – A heating element whose visible portion attains a temperature of at least 650°C (1202°F) under intended conditions of operation.

3.16 WALL (OR CEILING) HUNG HEATER – A cord-connected heater having a mass not exceeding 50 pounds (22.7 kg) that is attached to the wall (or ceiling) in such a manner that it can be removed without the use of tools.

3.17 WALL (OR CEILING) MOUNTED HEATER – A heater that is permanently attached to the wall (or ceiling) in such a manner that tools are necessary for its removal.

4 Components

4.1 Except as indicated in 4.2, 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 used in the products covered by this standard.

4.2 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.

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

4.4 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.

5 Units of Measurement

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

6 References

6.1 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

7 Enclosure

7.1 The enclosure of a heater shall be so formed and assembled that it will have the strength and rigidity necessary to resist the abuses likely to be encountered during its intended service. The degree of resistance inherent in the appliance shall preclude total or partial collapse with the attendant reduction of spacings, loosening or displacement of parts, and other serious defects which alone or in combination constitute a risk of fire, electric shock, explosion, or injury to persons.

7.2 Among the factors taken into consideration if an enclosure is being judged for acceptability are its:

- a) Mechanical strength,
- b) Resistance to impact,
- c) Moisture-absorption properties,
- d) Flammability,
- e) Resistance to corrosion, and
- f) Resistance to distortion at temperatures

to which the enclosure may be subjected under conditions of intended or abnormal use. For the requirements for a polymeric enclosure or part of an enclosure of a polymeric material, see Polymeric Materials, Section 12.

7.3 The enclosure of a heater shall prevent molten metal, burning insulation, flaming particles, or similar material from falling on combustible materials, including the surface upon which the heater is supported.

7.4 The requirement in 7.3 necessitates use of a barrier:

- a) Under a motor unless:
 - 1) The structural parts of the motor or of the heater 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 heater if 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

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

4) The motor is impedance protected and the locked-rotor temperature of the motor winding is not more than 150°C (302°F) with the heater otherwise operating as intended.

b) Under wiring, unless the wire insulation is of the flame-retardant type, VW-1 (FR-1) or the equivalent.

It will also necessitate that a switch, transformer, relay, solenoid, or similar device be individually and completely enclosed except at terminals, unless it can be shown that malfunction of the component would not result in a risk of 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 connections (splices) or overload or overcurrent protective devices.

7.5 Except as noted in 7.6, an opening for ventilation in the enclosure, other than in the bottom, of a heater and an opening associated with the dissipation of heated air from the element shall be provided with one or more baffles that will prevent the emission of flame, molten metal, burning insulation, or similar material from the heater.

7.6 In a compartment other than one that houses an overload or overcurrent protective device, the baffles mentioned in 7.5 may be omitted if:

a) No ventilating opening in a vertical wall, other than one associated with the dissipation of heated air from the elements during intended operation of the heater, is more than 3/8 inch (9.5 mm) in width, or

b) The heater is constructed to be acceptable for the purpose, as shown by appropriate investigation.

7.7 Cast- and sheet-metal portions of the enclosure shall not be thinner than indicated in Table 7.1 unless the enclosure is found to be acceptable when judged under considerations such as are mentioned in 7.2 and 7.8.

Table 7.1
Minimum acceptable thicknesses of enclosure metal

Metal	At small, flat, unreinforced surfaces and at surfaces that are reinforced by curving, ribbing, and similar means (or are otherwise of a shape, size or both) to provide mechanical strength		At relatively large unreinforced flat surfaces	
	Inches	mm	Inches	mm
Die-cast metal	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	–	–
Galvanized sheet steel	0.029 ^a	0.74 ^a	–	–
Nonferrous sheet metal	0.036 ^a	0.91 ^a	–	–

^a Thinner sheet metal may be employed if found to be acceptable when the enclosure is judged under considerations such as those mentioned in 7.2 and 7.8.

7.8 In addition to being considered with reference to the factors mentioned in 7.2, an enclosure of sheet metal is to be judged with respect to its size and shape, the thickness of metal, and its acceptability for the particular application, considering the intended use of the heater.

7.9 At points where the face of an attachment-plug receptacle projects through it, the enclosure of a heater shall have a thickness not less than:

- a) 0.032 inch (0.81 mm) if of ferrous metal,
- b) 0.045 inch (1.14 mm) if of nonferrous metal, and
- c) 0.10 inch (2.5 mm) if of insulating material, except that an enclosure of insulating material may be of lesser thickness if formed or reinforced to provide physical strength. The insulating material shall be noncombustible.

8 Accessibility of Live Parts

8.1 An electrical part of a heater shall be so located or enclosed that protection against unintentional contact with uninsulated live parts will be provided, except that this requirement does not apply to a visibly glowing open-wire element and the connections immediately adjacent to the element. See 3.1, 8.2, 32.7 and 32.14. Insulated motor brush caps do not require additional enclosures.

8.2 The requirement in 8.1 does not apply to the sheath of an isolated metal-clad element in a heater having provision for grounding the enclosure, although such a sheath is considered to be a bare live part when spacings are being measured.

8.3 In determining if an opening in an enclosure is acceptable, consideration is to be given to:

- a) The proximity of uninsulated live parts (as determined by applying 8.1, 8.2, 8.4, 8.5, and 8.15 and
- b) The possibility of the emission of burning insulation, molten metal, and similar materials through the opening (as determined by applying 7.3 – 7.6.)

8.4 To reduce the likelihood of unintentional contact that may involve a risk of electric shock from an uninsulated live part or film-coated wire, an opening in an enclosure shall comply with either (a) or (b).

- a) For an opening that has a minor dimension (see 8.8) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 8.3.
- b) For an opening that has a minor dimension of 1 inch or more, such a part or wire shall be spaced from the opening as specified in Table 8.1.

Exception: An integral enclosure of a motor need not comply with these requirements if it complies with the requirements in 8.5.

8.5 With respect to a part or wire as mentioned in 8.4, in an integral enclosure of a motor as mentioned in the exception to 8.4:

- a) An opening that has a minor dimension (see 8.8) less than 3/4 inch (19.1 mm) is acceptable if:
 - 1) Film-coated wire cannot be contacted by the probe illustrated in Figure 8.2;
 - 2) In a directly accessible motor (see 8.9), an uninsulated live part cannot be contacted by the probe illustrated in Figure 8.4; or
 - 3) In an indirectly accessible motor (see 8.9), an uninsulated live part cannot be contacted by the probe illustrated in Figure 8.1.
- b) An opening that has a minor dimension of 3/4 inch (15.1 mm) or more is acceptable if a part or wire is spaced from the opening as specified in Table 8.1.

Table 8.1

Minimum acceptable distance from an opening to a part that may involve a risk of electric shock

Minor dimension ^a of opening		Minimum distance from opening to part	
Inches ^b	mm ^b	Inches ^b	mm ^b
3/4 ^c	(19.1)	4-1/2	(114.0)
1 ^c	(25.4)	6-1/2	(165.0)
1-1/4	(31.8)	7-1/2	(190.0)
1-1/2	(38.1)	12-1/2	(318.0)
1-7/8	(47.6)	15-1/2	(394.0)
2-1/8	(54.0)	17-1/2	(444.0)
d		30	(726.0)

^a See 8.8.
^b Between 3/4 inch and 2-1/8 inches, interpolation is to be used to determine a value between values specified in the table.
^c Any dimension less than 1 inch applies to a motor only.
^d More than 2-1/8 inches, but not more than 6 inches (152.0 mm).

8.6 The probes mentioned in 8.4 and 8.5 and illustrated in Figures 8.1, 8.2, 8.3, and 8.4 shall be applied to any depth that the opening will permit; and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the enclosure. The probes illustrated in Figures 8.3 and 8.4 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

Figure 8.1
Probe for uninsulated live parts

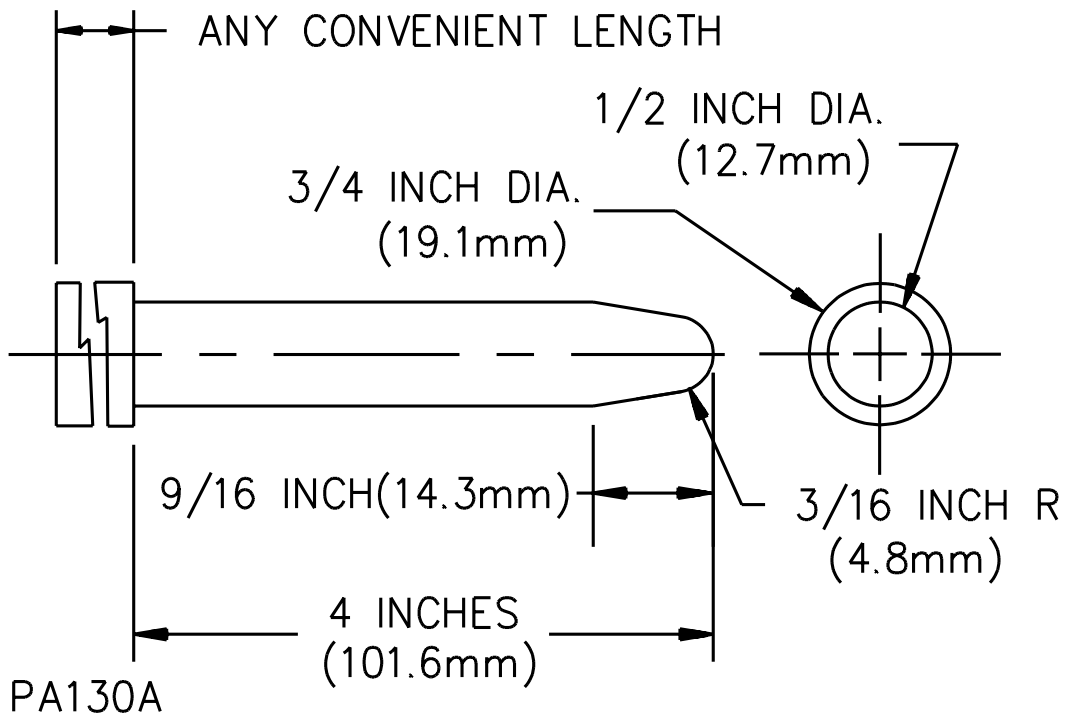
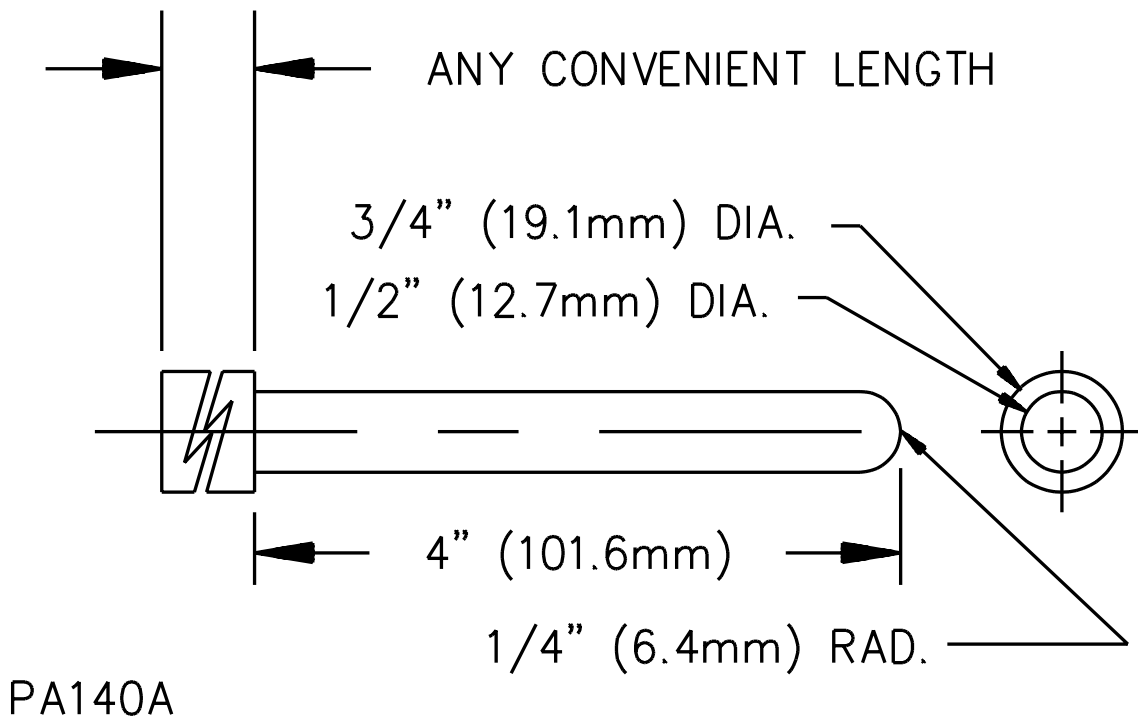


Figure 8.2
Probe for film-coated wire



8.7 The probes mentioned in 8.6 and 8.8 shall be used as measuring instruments to judge the accessibility provided by an opening, and not as instruments to judge the strength of a material; they shall be applied with a force of 1 lb (4.4 N) through any opening.

8.8 With reference to the requirements in 8.4 and 8.5, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening.

8.9 With reference to the requirements in 8.5, an indirectly accessible motor is a motor:

- a) That is accessible only by opening or removing a part of the outer enclosure, such as a guard or panel, that can be opened or removed without using a tool, or
- b) That is located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted.

A directly accessible motor is a motor:

- c) That can be contacted without opening or removing any part, or
- d) That is located so as to be accessible to contact.

8.10 During the examination of a heater in connection with the requirements in 8.1 – 8.9, a part of the outer enclosure that may be removed without the use of tools by the user of the heater (to permit the attachment of accessories, to allow access to means for making operating adjustments, or for other reasons) is to be disregarded – that is, it will not be assumed that the part in question affords protection against the risk of electric shock. A warning marking such as that specified in 64.5 is not considered to adequately protect against this risk of electric shock.

8.11 With reference to the requirements in 8.4 and 8.5, insulated brush caps are not required to be additionally enclosed.

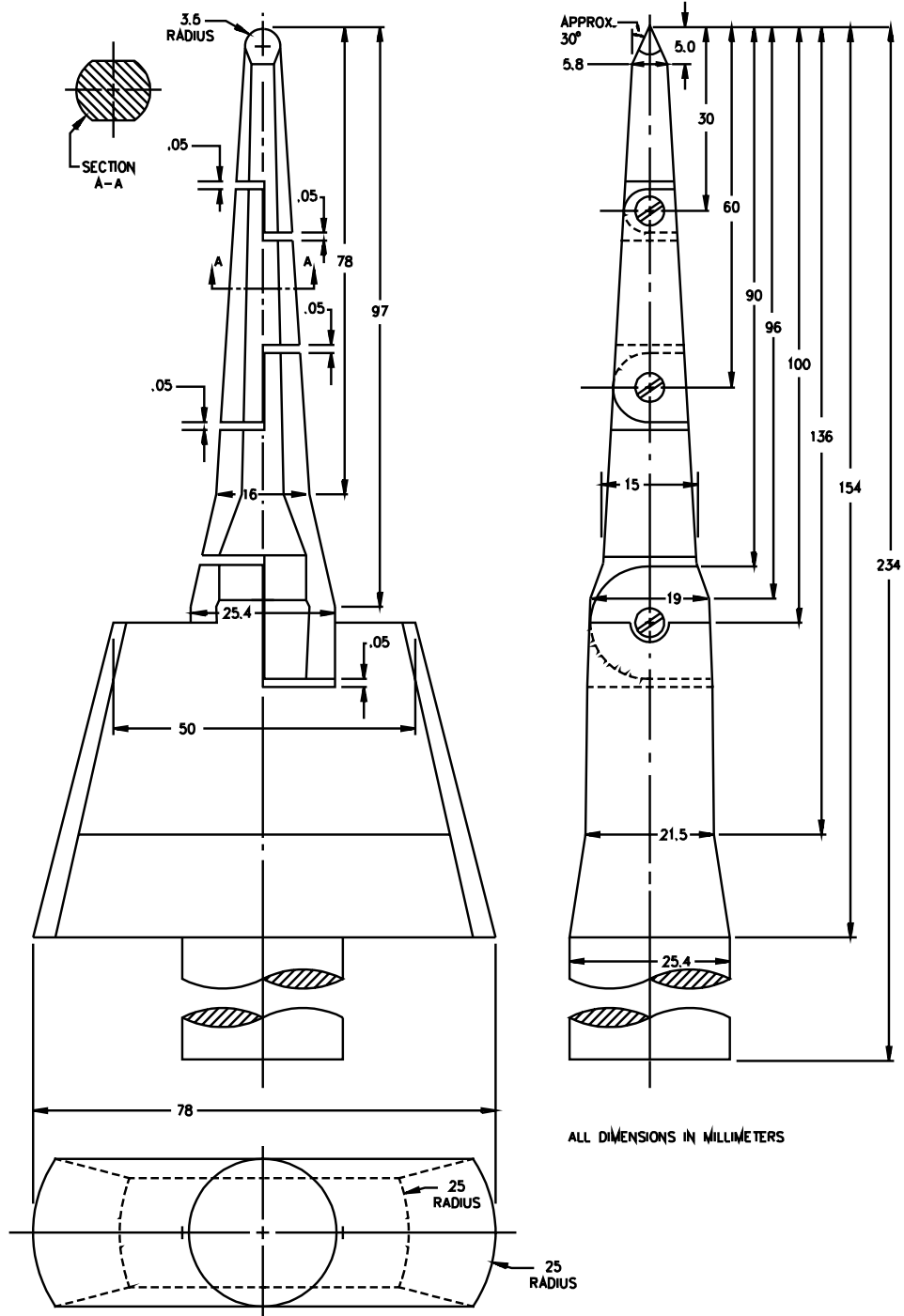
8.12 During the examination of a heater in connection with the requirements in 8.1 – 8.9, a part of the outer enclosure that is removed with the use of tools by the user of the heater to permit resetting of the resettable temperature control is to be disregarded – that is, it will not be assumed that the part in question affords protection against the risk of electric shock, or injury to persons. A warning marking such as that specified in 64.5 is not considered to adequately protect against this risk of electric shock, or injury to persons.

Exception: A heater marked in accordance with 64.4 and that complies with 8.13 need not comply with this requirement.

8.13 A product may employ a resettable temperature control when the reset means is inaccessible if designed in a manner that the product cannot be disassembled with readily available tools, such as screw drivers, wrenches, and similar tools, and the product is marked in accordance with 64.4. Such fasteners as rivets, one way screws, fasteners not readily accessible after assembly, and similar fasteners would be considered as causing the product to be not readily disassembled.

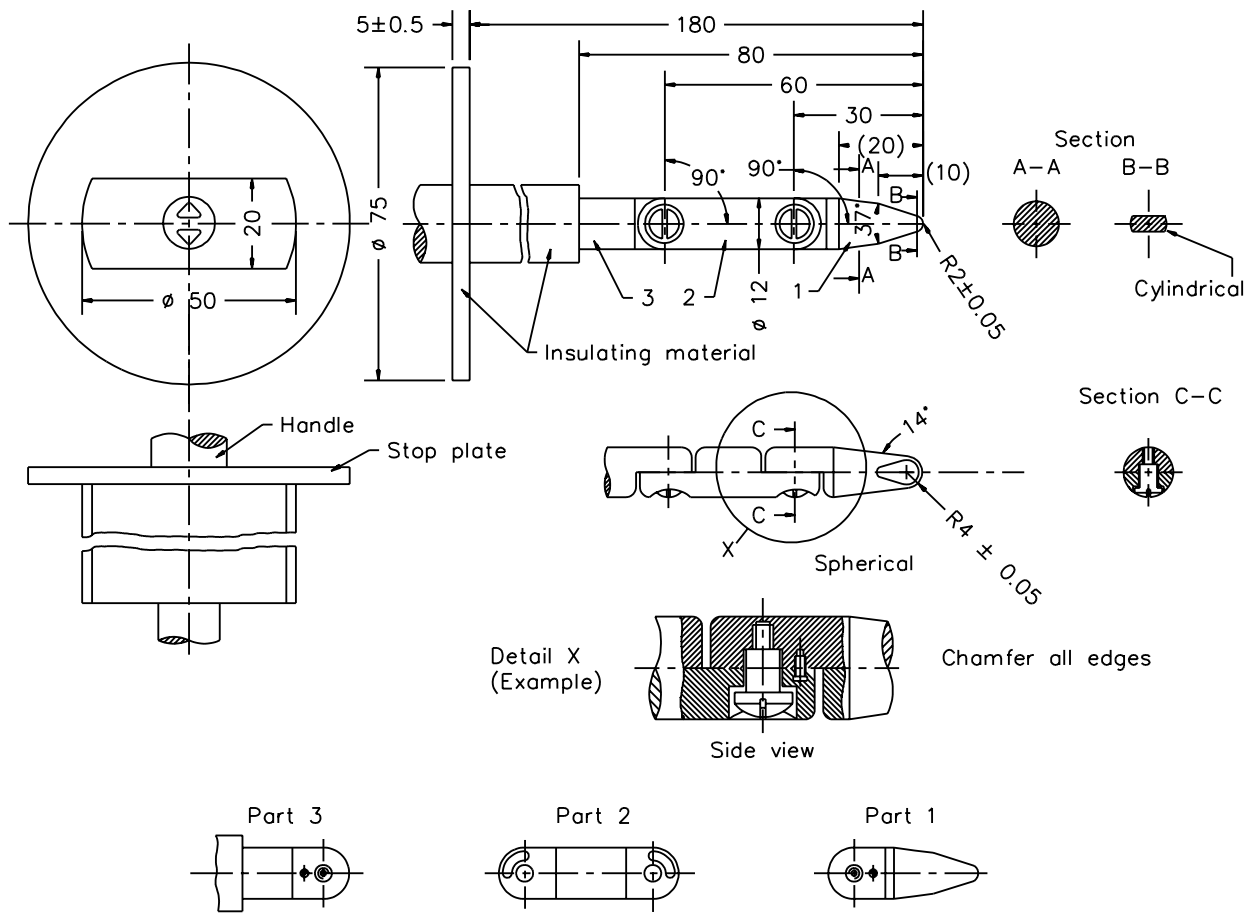
8.14 Any manual adjustable controls shall be resettable or adjustable so that electrical or moving parts will not cause a risk of fire, or electric shock, to occur during the resetting or adjustment procedure. See Figure 8.5 and 8.10 and 8.12.

Figure 8.3
Articulate probe with web stop



PA100A

Figure 8.4
Articulate probe



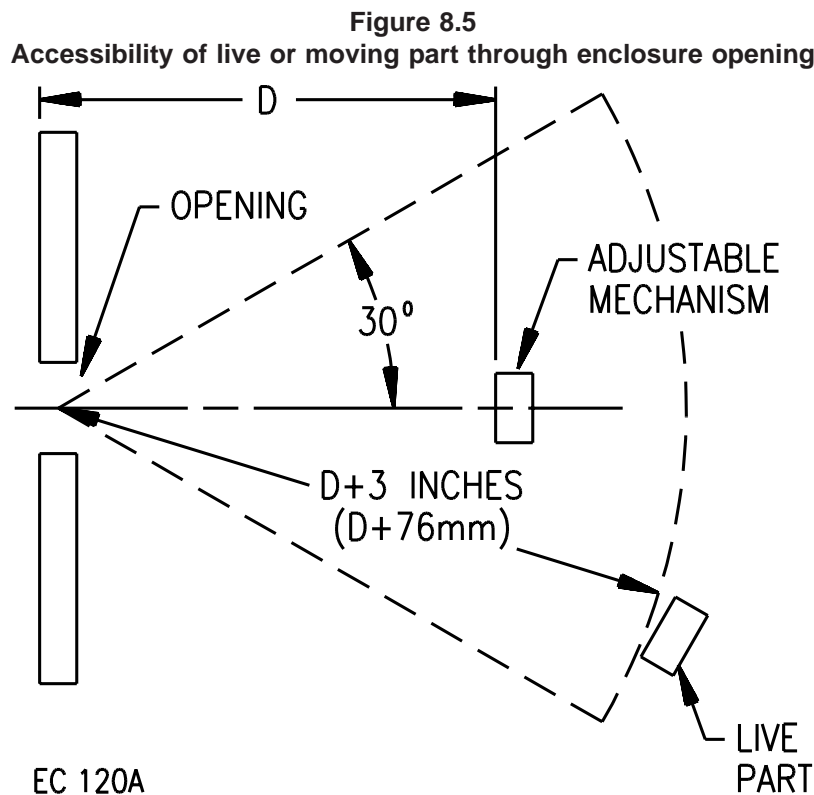
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All dimensions in millimeters

8.15 An uninsulated live part shall not be located behind an opening that may be used to make a user service function such as adjusting or resetting a manual limit control if a 1/8-inch (3.2-mm) diameter straight rod can be made to touch the live part when the rod is inserted through the opening and moved to all positions possible without producing an angle of more than 30 degrees between the rod and the line drawn between the center of the opening and the center of the face of the part to be adjusted. The length of the rod beyond the opening is not to exceed the distance between the opening and the face of the adjustable mechanism by more than 3 inches (76 mm). See Figure 8.5.

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

8.17 The door or cover of an enclosure shall be hinged if it gives access to any fuse, circuit breaker, or manually resettable temperature control and if uninsulated live parts are exposed during the replacement of the fuse or resetting of the manually resettable temperature control. Such a door or cover shall also be provided with a latch or the equivalent and a captive screw to secure the door or cover in place.



8.18 A door or cover giving access to any overload-protective device in other than a low-voltage circuit shall be tight fitting and shall suitably overlap the surface of the enclosure around the opening.

8.19 A spring latch, a magnetic latch, a dimple, or any other mechanical arrangement that will hold the door in place and would require some effort on the user's part to open it is considered to be an acceptable means for holding the door in place as required in 8.17.

8.20 A component of a heater that is likely to need inspection, replacement, cleaning, or other servicing shall be as accessible as practicable, and shall be accessible without the use of special tools if it is intended to be manually operated or adjusted or if it will definitely require periodic servicing.

9 Accessibility of Moving Parts

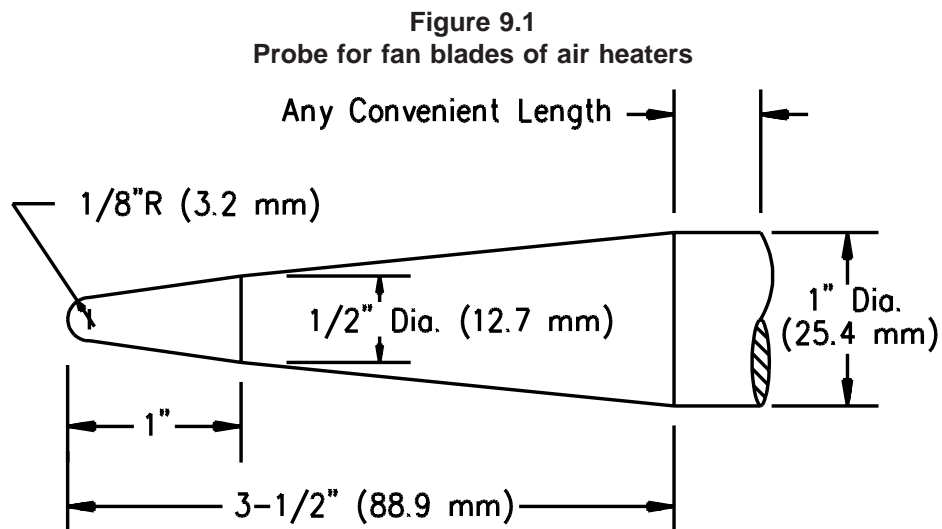
9.1 The rotor of a motor, a pulley, a belt, a gear, a fan, or other moving parts shall be enclosed or guarded to reduce the risk of injury to persons.

Exception: This requirement does not apply to a part or portion of a part that must be exposed to enable a heater to perform its intended function.

9.2 A fan blade shall be constructed of a material and in such a manner to reduce the risk of its breakage or its release of parts that could cause a risk of injury to persons.

9.3 The portion of a fan blade that can cause a risk of injury to persons shall be guarded so that the probe shown in Figure 9.1 cannot touch the part when inserted with a force of 1 lb (4.4 N) through any opening in the guard.

9.4 If a part used to comply with the requirement in 9.3 is made of a polymeric material, a piece of the material is to be re-examined for compliance with this requirement after being subjected to the Mold Stress-Relief Distortion Test as described in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. See 12.1. While in the oven the part is to be assembled to the heater and the heater is to be in its intended operating position.



9.5 A guard employed to comply with the requirement in 9.3 shall be either attached to the heater or shall require the use of a tool or tools for removal.

9.6 An enclosure, a frame, a guard, a handle, or other part of the heater that is exposed to contact during intended operation shall not be sufficiently sharp to constitute a risk of injury to persons.

9.7 Any manual adjustable controls shall be resettable or adjustable so that moving parts will not cause a risk of injury to persons to occur during the resetting or adjustment procedure. See Figure 8.5, 8.10 and 8.12.

10 Guarding of Heating Elements

10.1 General

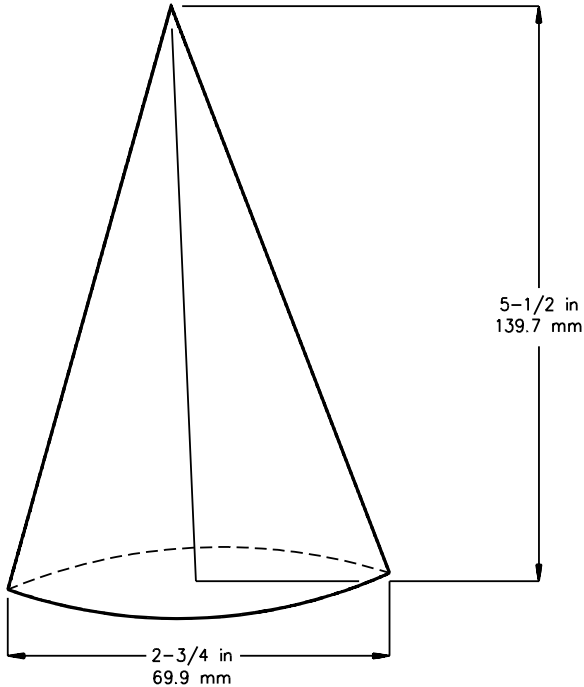
10.1.1 The heating element and any part of the element assembly (such as an element support, sheath, and similar parts) shall be so guarded that flammable material as well as persons will be protected against contacting it.

10.1.2 Any heater projections such as guards or grilles that are intended to guard hot heater surfaces shall be positively secured to the heater such as by screws, rivets or welding or being engaged in slots so that they cannot be removed without the use of tools, breaking or permanent bending or distortion.

10.1.3 The acceptability of a guard is judged with respect to its general serviceability and with respect to the shape and size or both of the openings in it, in conjunction with the distance of the guard from the heating element and the other high-temperature parts mentioned in 10.1.1. Except as noted in 10.1.5, an opening in a guard is considered to be acceptable if, with the heater in any intended operating position, the following conditions are met:

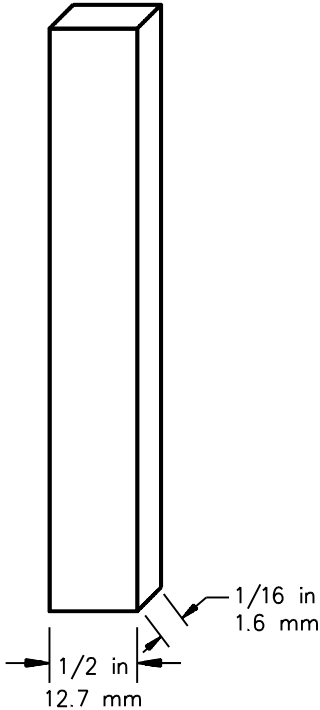
- a) The shape and size of an opening are such that a test gauge in the form of a right-circular cone having a base diameter of 2-3/4 inches (69.9 mm) and an altitude of 5-1/2 inches (139.7 mm), see Figure 10.1, is prevented from touching the heating element and the other high-temperature parts when the cone probe is inserted, apex first, in any manner. See 10.1.4.
- b) The shape and size of an opening which permits the vertically downward entrance of a bar probe 1/2 inch (12.7 mm) wide and 1/16 inch (1.6 mm) thick, see Figure 10.2, are such that a triangle probe 1/16 inch thick and in the form of an isosceles triangle having a base of 2-3/4 inches and an altitude of 5-1/2 inches, see Figure 10.3, is prevented from touching the heating element and the other high-temperature parts when the triangle probe is inserted, apex first, in any manner. The testing of an opening with the triangle probe applies also where the vertically downward insertion of the bar is prevented by the construction of the guard, the use of an additional barrier, or both, unless the vertically applied bar tends to be deflected outward – that is, away from the guard.
- c) The area of an opening in a substantially vertical face of a guard is not more than 3-1/4 square inches (2100 mm²) if the size and/or shape of the opening permits the entrance from any horizontal direction of a vertically oriented rod probe 1/16 inch in diameter and 2-3/4 inch long, see Figure 10.4. Also, see Figure 10.5.

Figure 10.1
Cone probe



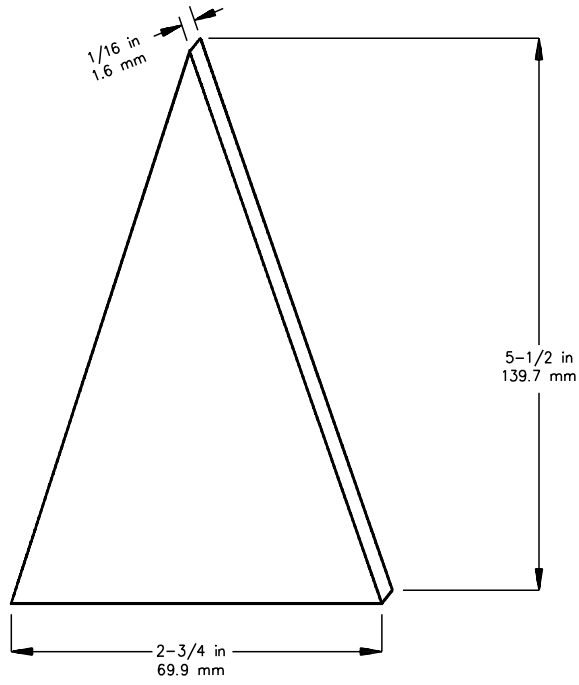
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Figure 10.2
Bar probe



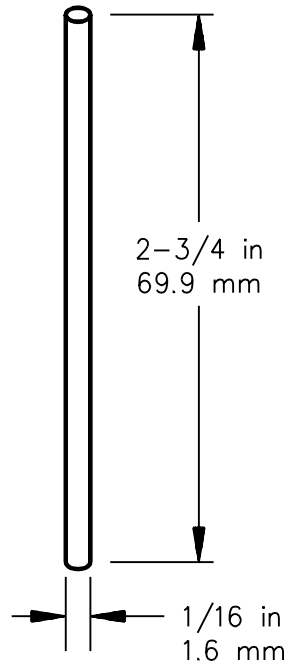
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Figure 10.3
Triangle probe



SM208

Figure 10.4
Rod probe

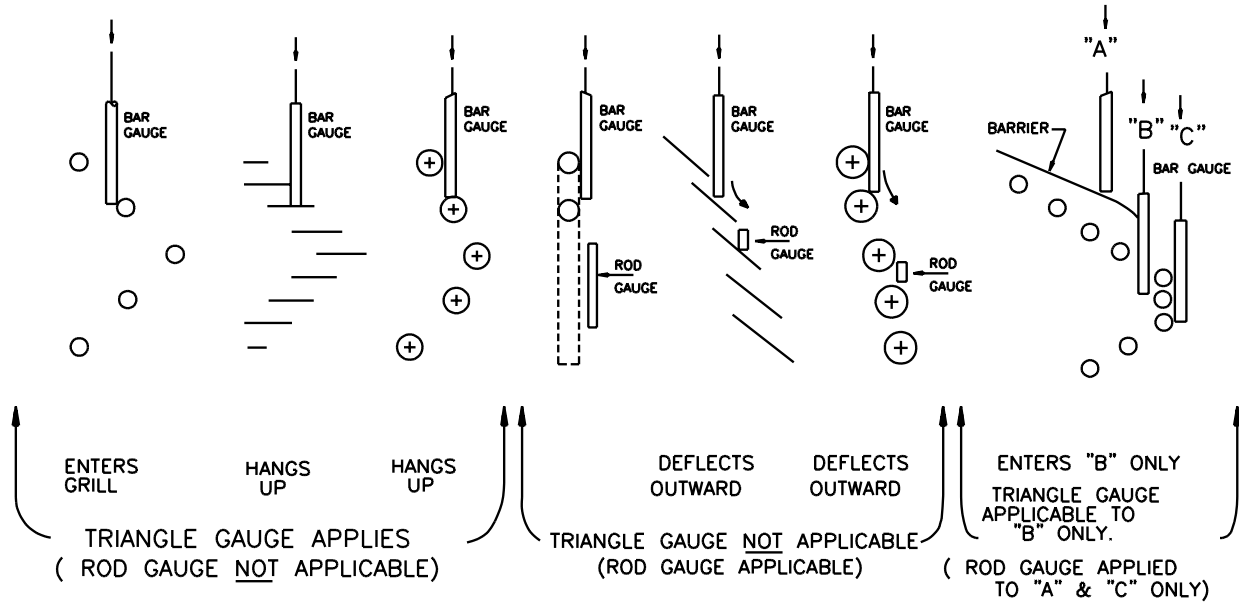


SM209

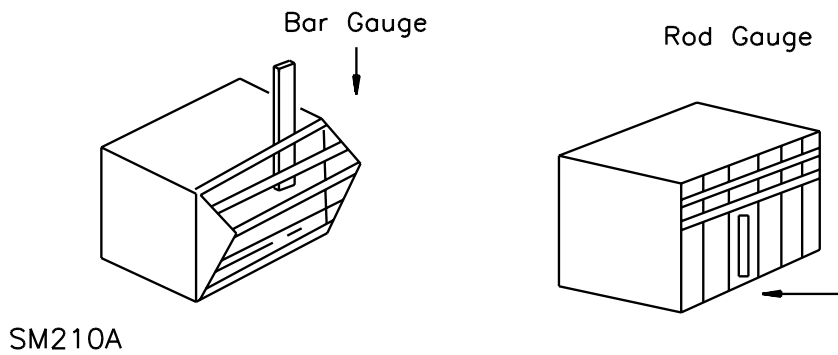
Figure 10.5
Guarding of heating elements

Application of bar gauge and rod gauge

ARROW INDICATES DIRECTION OF APPLICATION OF GAUGES



NOTE: ROD GAUGE APPLIED TO "SUBSTANTIALLY VERTICAL" GRILLS.



10.1.4 The fins of a metal-clad element are considered to be element-guarding members, and need not comply with the provisions in 10.1.3(a) if the temperature of the exposed edges (outer perimeter) of the fins is not more than 280°C (536°F).

10.1.5 Openings in the guard complying only with of 10.1.3(a) are acceptable for the following:

- a) Except for a panel-type heater (see 10.2.1), an air heater in which the temperature of the heating element is not higher than 280°C (536°F) under conditions of intended operation, or
- b) A fan-type heater in which the fan is always in operation when the heating element is on (energized) and the air current prevents clothing and the like from entering the guard.

10.1.6 A guard shall comply with one of the following if the switching arrangement on a grounded heater does not comply with 32.14 or the design employs a through-cord switch as described in 32.15.

- a) No opening in the guard will permit passage of a rod having a diameter of 3/8 inch (9.5 mm).
- b) No opening in the guard will permit passage of a rod having a diameter of 3/4 inch (19.1 mm) and no uninsulated live part or isolated metal-clad element is less than 4 inches (102 mm) from the nearest point on the guard at any opening which will permit the entrance of a rod having a diameter of 3/8 inch (9.5 mm).

10.1.7 If a heater is required to have a guard, and if the guard is readily removable, the heater and the guard shall be contained in the same carton as shipped from the factory. See also 64.17.

10.1.8 A heater in which the heating element is constructed for use only in an air current shall be so wired or controlled that the element can be operated only while under the cooling effect of the air stream. A heater 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.

10.2 Panel-type heaters

10.2.1 A panel-type heater shall be provided with a guard that will prevent a test surface, in the form of a 6-inch square (a square 152 mm on a side) parallel to the element panel, from being brought closer than 1/2 inch (12.7 mm) to the plane of the front of the heater, excluding the guard.

Exception No. 1: A heater having an element panel operating at a temperature higher than 280°C (536°F) shall be guarded as described in 10.1.3.

Exception No. 2: A heater that will not cause glowing or flaming of the cheesecloth or the felt when subjected to the padded surface and blanketing test in 41.8.2.

11 Parts Subject to Pressure

11.1 Except as noted in 11.2 a pressure vessel having an inside diameter, width, height or cross-section diagonal of more than 6 inches (152 mm) with no limitation on length of vessel and subject to a pressure of more than 15 pounds force per square inch gauge (psig) (103 kilonewtons per square meter or 105 grams force per square millimeter) shall be certified by the National Board of Boiler and Pressure-Vessel Inspectors and marked in accordance with the appropriate boiler and pressure vessel code symbol of the American Society of Mechanical Engineers (ASME) – "H ", "M ", "S ", or "U " – for a working pressure not less than the pressure determined by applying 11.2.

11.2 Except as noted in 11.3, a part of a heater that is subject to pressure (including the vapor pressure of a superheated fluid) shall comply with the Hydrostatic Test, Section 57.

11.3 A test need not be performed to determine whether or not a part complies with the requirement in 11.2 if the strength of the part is acceptable for the purpose as a result of its material and dimension – for example, copper or steel pipes of standard sizes and provided with standard fittings might be considered to have the necessary strength if they comply with Table 11.1.

Table 11.1
Minimum wall thickness^a for copper and steel tubing

Outside diameter		Copper				Steel	
		Protected within the enclosure		Unprotected			
inches	mm	inches	mm	inches	mm	inches	mm
1/4	6.35	0.0245	0.623	0.0265	0.673	0.025	0.635
5/16	7.94	0.0245	0.623	0.0265	0.673	0.025	0.635
3/8	9.53	0.0245	0.623	0.0265	0.673	0.025	0.635
1/2	12.70	0.0245	0.623	0.0285	0.724	0.025	0.635
5/8	15.88	0.0315	0.799	0.0315	0.799	0.032	0.813
3/4	19.05	0.0315	0.799	0.0385	0.978	0.032	0.813
7/8	22.23	0.0410	1.041	0.0410	1.041	0.046	1.168
1	25.40	0.0460	1.168	0.0460	1.168	–	–
1-1/8	28.58	0.0460	1.168	0.0460	1.168	0.046	1.168
1-1/4	31.75	0.0505	1.283	0.0505	1.283	0.046	1.168
1-3/8	34.93	0.0505	1.283	0.0505	1.283	–	–
1-1/2	38.10	0.0555	1.410	0.0555	1.410	0.062	1.575
1-5/8	41.28	0.0555	1.410	0.0555	1.410	–	–
2-1/8	53.98	0.0640	1.626	0.0640	1.626	–	–
2-5/8	66.68	0.0740	1.880	0.0740	1.880	–	–

^a Nominal wall thickness of tubing will have to be greater than the thickness indicated to maintain the minimal wall thickness.

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

11.5 Pressure-relief devices (see 11.10), fusible plugs, soldered joints, spot or rolled weld joints, nonmetallic tubing, or other equivalent pressure-relief means may be employed to comply with the requirement in 11.4.

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

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

11.8 The start-to-discharge pressure setting of the pressure-relief device shall not be higher than the maximum working pressure of the vessel. The discharge rate of the device shall be great enough to relieve the pressure.

11.9 A pressure-relief device shall:

- a) Be connected as close as possible to the pressure vessel or parts of the system that it is intended to protect,
- b) Be so installed that it is accessible for inspection and repair and cannot be readily rendered inoperative,
- c) Have its discharge opening so located and directed that the risk of scalding has been reduced to an acceptable degree, and
- d) Have its discharge opening so located and directed that operation of the device will not deposit moisture on uninsulated live parts, or on insulation or components affected detrimentally by moisture.

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

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

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

12 Polymeric Materials

12.1 Determination of the acceptability of a polymeric material shall be made based on the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

12.2 For the purposes of conducting the Resistance to Impact Test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, a heater intended for indoor use that is provided with a polymeric enclosure shall be considered a floor-supported appliance even if it is specifically intended for use at elevated locations and be evaluated for use in locations where the temperature is capable of being less than normal room temperature, such as unheated warehouses or rooms.

Added 12.2 effective December 21, 2000

13 Heat Transfer Fluids

13.1 General

13.1.1 In a heater which uses a heat transfer fluid in its heating process, the fluid shall have a flash point (see 3.8) that is higher than the maximum operating temperature of the fluid measured during the Normal Temperature Test, Section 39.

14 Assembly of Components

14.1 A switch, a lampholder, a temperature control, an attachment-plug receptacle, a motor-attachment plug, or similar component shall be mounted securely and, except as noted in 14.2 and 14.3, shall be prevented from turning.

14.2 The requirement that a switch or a temperature control be prevented from turning may be waived if all five of the following conditions are met:

- a) The switch or the temperature control is of a plunger or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch or the temperature control during operation of the switch,
- b) The means for mounting the switch or the temperature control is not subject to loosening as the result of its operation,
- c) The spacings are not reduced below the minimum acceptable values if the switch or the temperature control rotates,
- d) The operation of the switch or the temperature control is by mechanical means rather than direct contact by persons, and
- e) The shifting of the switch or the temperature control in position does not result in false indication of its setpoint with respect to the setpoint markings.

14.3 A lampholder of a type in which the lamp cannot be replaced (such as a neon pilot or indicator light in which the lamp is sealed in nonremovable jewel) need not be prevented from turning if rotation cannot reduce spacings below the minimum acceptable values.

14.4 The means for preventing the turning mentioned in 14.1 is to consist of more than friction between surfaces – for example, a toothed lock washer which provides both spring take-up and an interference lock is acceptable as means to prevent turning of a small stem-mounted switch or other device having a single-hole mounting means.

14.5 Uninsulated live parts shall be secured to the base or mounting surface that they will be prevented from turning or shifting in position if such motion may result in a reduction of spacings below the minimum acceptable values indicated in 34.1 – 34.6.

14.6 Friction between surfaces is not acceptable as a means to prevent shifting or turning of live parts, but a toothed lock washer which provides both spring take-up and an interference lock is acceptable.

15 Protection Against Corrosion

15.1 Except as noted in 15.2, iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means if the deterioration of such unprotected parts would be likely to result in risk of fire, electric shock, explosion, or injury to persons.

15.2 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.

15.3 The aging characteristics of plating or other finish used in a heater shall be such that deterioration of the finish will not result in unacceptable performance of the heater.

15.4 The sheath of an immersion-type heating element shall be of a metal resistant to corrosion by the liquid in which the element is intended to be immersed.

16 Supply Connections

16.1 The mass of a wall or ceiling hung heater shall not exceed 50 pounds (22.7 kg).

16.2 Hanging brackets and any necessary fasteners required for hanging the heater shall be provided as part of the product. Optional hanging kits may be available if marked in accordance with 64.10.

16.3 A wall-hung heater shall not have provisions for permanent mounting. Keyhole slots, not accessible for tightening of screws, or provisions for hanging on a bracket furnished with a heater would be acceptable for mounting such heaters.

16.4 A heater 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 detachable power-supply cord or attached power-supply cord (including fittings) shall not be less than 6 feet (1.8 m) and not more than 8 feet (2.4 m). All detachable power-supply cords and attached power-supply cords shall comply with the requirements of the Standard for Cord Sets and Power-Supply Cords, UL 817.

Exception No. 1: The length of cord for Types SRDT and SPT-3 is specified in note b of Table 16.1.

Exception No. 2: Ceiling-hung heaters may have a cord not more than 17 feet (5.2 m) in length.

Table 16.1
Acceptable types of cord

Type of heater	Temperature of more than 121°C (250°F) on any heater surface likely to be contacted by cord ^{c,d}	Temperature of 121°C (250°F) or less on any heater surface likely to be contacted by cord ^{a,c,d}
Household heaters not intended for outdoor use	HPD, HPN, HSJO, HSJ	SP-2, SPT-2, SVO, SV, SVTO, SVT, SJO, SJ, SJTO, SJT, SRDT ^b , SPT-3 ^b
Commercial heaters not intended for outdoor use	HSJO, HSJ, HSO, HS	SJO, SJ, SJTO, SJT, SO, S, STO, ST, SRDT ^b , SPT-3 ^b

^a Cords of the types indicated in the adjacent column may also be used.

^b Restricted to a wall supported or a freestanding heater having a minimum cord length of 3 feet (0.9 m) and a maximum cord length of 6 feet (1.8 m).

^c On a movable heater it is considered that any external surface that can be contacted by the cord is likely to be contacted by the cord.

^d The maximum temperature on a heater is to be determined in accordance with the Normal Temperature Test (Section 39).

16.5 The size of the flexible cord, based on the current rating of the heater, shall be in accordance with Table 16.2.

Table 16.2
Cord wire size based on heater current rating^a

		Maximum current rating of heater, amperes	
		Attachment plug connection soldered, brazed, or welded ^d	
Cord wire size AWG ^b	Attachment plug connection crimped only ^c	Cord types S, SJ, SJO, SJT, SJTO, SO, SP, SPT, SRDT, ST, STO, SV, SVO, SVT, SVTO	Cord types HPD, HPN, HS, HSJ, HSJO, HSO
18	8	10	10
16	10.4	13	15
14	14.4	18	20

^a This table limits the heater current on the basis of cord wire size, type of cord, and type of connection between the cord wires and blades of the attachment plug. For current limitation based on the attachment plug rating, see 16.6.

^b The maximum current rating for other cord sizes can be determined from Table 400-5(A), Ampacity of Flexible Cords and Cables, National Electrical Code, ANSI/NFPA 70. When the attachment plug is connected by crimping only, the current rating of the heater is not to exceed 80 percent of the rating of the corresponding wire sizes of Type S Cord, regardless of the type of cord used.

^c Applies to any acceptable cord type.

^d A soldered connection shall be mechanically secured before being soldered. A soldered connection that is crimped before being soldered is considered to be mechanically secured before soldering. A brazed or welded connection may additionally be mechanically secured before brazing or welding.

16.6 The current rating of the attachment plug shall not be less than 125 percent of the current rating of the heater except that a 15-ampere attachment plug is acceptable for a heater rated at not more than 1500 watts at 120 volts, or 3000 watts at 240 volts, and a 20-ampere attachment plug is acceptable for a heater rated at not more than 2000 watts at 120 volts or 4000 watts at 240 volts.

16.7 The flexible cord shall be as indicated in Table 16.1 or shall be of type having such properties that it will be at least equally serviceable for the particular application.

16.8 The flexible cord provided with a heater intended for outdoor use shall be marked with the suffix letter "W".

16.9 The attachment plug (of a permanently attached cord or of a cord set) shall be acceptable for its intended use. Some of the more common plug configurations are shown in Figure 16.1.

16.10 Supplementary insulation on a flexible cord shall not extend more than 1/2 inch (12.7 mm) outside the heater (unless provided with additional mechanical protection), shall be prevented from fraying or unraveling, and shall not affect adversely the means for providing strain relief.

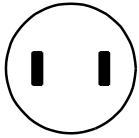
16.11 Strain relief shall be provided to prevent a mechanical stress on a flexible supply cord from being transmitted to terminals, splices, or interior wiring.

16.12 Means shall be provided to prevent the flexible cord from being pushed into the enclosure of a heater through the cord-entry hole if such displacement is likely to subject the cord to mechanical damage or to expose the cord to a temperature higher than that for which it is acceptable, or if it is likely to reduce spacings (such as to a metal strain-relief clamp) below the minimum acceptable values.

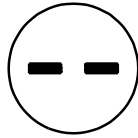
16.13 If a knot serves as strain relief in an attached flexible cord, any surface with which the knot may come in contact shall be free from projections, sharp edges, burrs, fins, and the like, which may cause abrasion of the insulators on the conductors.

Figure 16.1
Attachment plug configurations

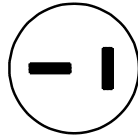
2-POLE, 3-WIRE, NONGROUNDING:



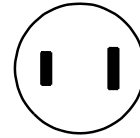
15 amperes,
125 volts



15 amperes,
250 volts

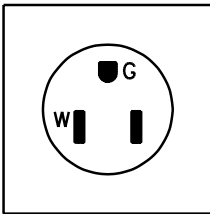


20 amperes,
250 volts

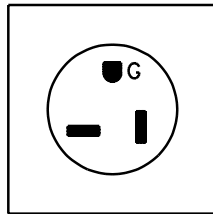


30 amperes,
250 volts

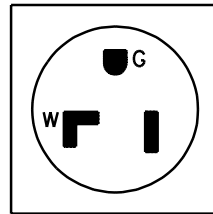
2-POLE, 3-WIRE, GROUNDING:



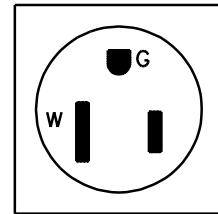
15 amperes,
125 volts



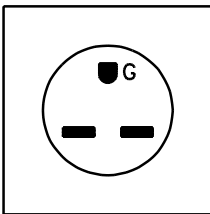
20 amperes,
125 volts



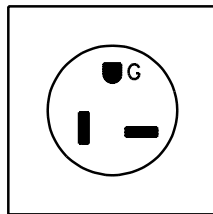
30 amperes,
125 volts



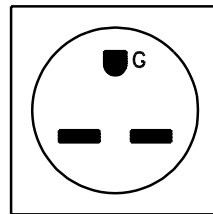
50 amperes,
125 volts



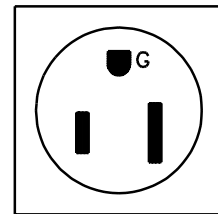
15 amperes,
250 volts



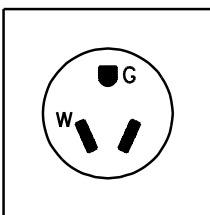
20 amperes,
250 volts



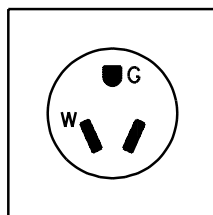
30 amperes,
250 volts



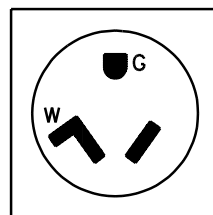
50 amperes,
250 volts



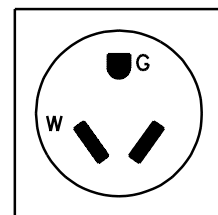
15 amperes,
277 volts



20 amperes,
277 volts



30 amperes,
277 volts



50 amperes,
277 volts

16.14 If a heater is provided with pin terminals, the heater shall be constructed so that no live parts will be exposed to unintentional contact when the intended plug is in place on the pins.

16.15 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 shown in Figure 8.3 shall not touch any current-carrying pin while the probe is inserted through any opening with the heater in any position.

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

16.17 The requirement in 16.16 is intended primarily to provide for the maintenance of spacings in accordance with 34.1 – 34.6 and Table 34.1, and for spacings between pin-type terminals as indicated in Table 16.3. Under this requirement, consideration is also to be given to the means for locking terminals in position to maintain tightness.

**Table 16.3
Pins**

Type and rating of plug which accommodates the pins	Configuration of pins				Diameter of pins		Length of pins	
	Number	Arrangements	Spacings between centers		Inches	mm	Inches	mm
			Inches	mm				
Appliance plug rated for 5 amperes at 250 volts and for 10 amperes at 125 volts	2	in line	1/2	12.7	5/32 ±0.005	3.97 ±0.13	9/16 – 5/8	14.3 – 15.9
Flatiron plug rated for 5 amperes at 250 volts and for 10 amperes at 125 volts	2	in line	11/16	17.5	3/16 ±0.005	4.76 ±0.13	3/4 – 7/8	19.1 – 22.2
Jumbo appliance plug rated for 10 amperes at 250 volts and for 15 amperes at 125 volts	2	in line	1-1/16	27.0	3/16 ±0.005	4.76 ±0.13	3/4 – 7/8	19.1 – 22.2
Reversible plug (for two-heat control) rated for 10 amperes at 250 volts and for 15 amperes at 125 volts ^a	3	in line	7/8	22.2	3/16 ±0.005	4.76 ±0.13	3/4 – 7/8	19.1 – 22.2
Reversible plug (for two- or three-heat control) rated for 10 amperes at 250 volts and for 15 amperes at 125 volts ^a	3	One pin at each apex of an equilateral triangle	7/8	22.2	3/16 ±0.005	4.76 ±0.13	3/4 – 7/8	19.1 – 22.2

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

16.18 If a heater employs three or more pin terminals intended 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 a cord connector; and the plug that these pins will accommodate shall be acceptable for the particular application.

16.19 The dimensions of pins and their center-to-center spacings (including the corresponding spacings of the female contacts of general-use plugs which will accommodate these arrangement of pins) are as indicated in Table 16.3.

16.20 At 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, rounded surface against which the cord may bear. If Type 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 acceptable for the particular application.

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

16.22 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 conditions of ordinary moisture.

17 Current-Carrying Parts

17.1 Plated ferrous materials may be used for current-carrying parts whose temperature during normal operation is more than 100°C (212°F), but plain (unplated) iron or steel shall not be used regardless of temperatures. A copper conductor, unless tinned, nickel-coated, silver-plated, or otherwise protected, shall not be subjected to a temperature rise of more than 125°C (225°F) at a pressure terminal connector or to a temperature rise of more than 175°C (315°F) elsewhere. Stainless steel and other corrosion-resistant alloys may be used for current-carrying parts regardless of temperature.

17.2 Ordinary ferrous materials, if provided with a corrosion-resistant coating, may be used for a current-carrying part as follows:

- a) Within a motor or associated governor, and
- b) On control-devices (such as combination tip-over and temperature controls) if the part has been evaluated as acceptable for use in an ambient temperature in excess of 100°C (212°F).

18 Internal Wiring

18.1 General

18.1.1 The internal wiring of a heater 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.

18.1.2 For the purpose of these requirements, the internal wiring of an appliance is considered to be all the interconnecting wiring beyond the point where the power-supply cord enters the enclosure.

18.1.3 There is no temperature limit applicable to a conductor (except as noted in 17.1) provided with beads of noncarbonizable material or the equivalent.

18.2 Protection of wiring

18.2.1 The wiring and connections between parts of a heater 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.

18.2.2 The internal wiring of a heater in the vicinity of a lampholder that accepts either an infrared lamp or an ordinary lamp:

- a) Shall be a jacketed type at least equivalent to Type SP-2 flexible cord. Asbestos-insulated wiring and appliance wiring material is not acceptable unless provided with sleeving or tubing.
- b) Shall be routed along the metal surface of the heater enclosure and shall be so secured as to minimize the likelihood of its being hooked or grasped.

18.2.3 A conductor utilizing beads for insulation shall not be used outside an enclosure.

18.2.4 Internal wiring that is exposed through an opening in the enclosure of a heater is considered to be protected as required in 18.2.1 – 18.2.3 if, when judged as though it were film-coated wire, the wiring would be acceptable according to 8.2 – 8.4. 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.

18.2.5 If the wiring of a heater is located where it may be in proximity to combustible material or may be subjected to physical damage, it shall be in armored cable, rigid metal conduit, electrical metallic tubing, metal raceway, or shall otherwise be protected.

18.2.6 Wiring shall be protected from sharp edges (including male screw threads), burrs, fins, moving parts, and other agencies that might abrade the insulation on conductors.

18.2.7 A hole by means of which insulated wires pass through a sheet-metal wall within the overall enclosure of a heater shall be provided with a smooth, rounded bushing or shall have smooth, rounded surfaces upon which the wires may bear, to prevent abrasion of the insulation. A flexible cord used for external interconnection as mentioned in 18.2.1 shall be provided with strain relief and bushings in accordance with 16.11 – 16.13 and 16.20 – 16.22 unless the construction is such that the cord will be protected from stress or motion.

18.2.8 Insulated wires may be bunched and passed through a single opening in a metal wall within the enclosure of heater.

18.3 Wire connectors

18.3.1 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.

18.3.2 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 is not provided.

18.3.3 Insulation consisting of two layers of friction tape, of two layers of thermoplastic tape, or of one layer of friction tape wrapped over one layer of rubber tape is acceptable on a splice. In determining if 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, and the like. Thermoplastic tape wrapped over a sharp edge is not acceptable.

18.3.4 The means of connecting stranded internal wiring to a wire-binding screw shall be such that loose strands of wire will be prevented from contacting other live parts not always of the same polarity as the wire and from contacting noncurrent-carrying conductive parts. This may be accomplished by use of pressure terminal connectors, soldering lugs, crimped eyelets, soldering all strands of the wire, or other equivalent means.

18.4 Separation of circuits

18.4.1 Conductors of different circuits used in internal wiring shall either be:

- a) Provided with insulation rated for the highest voltage involved or
- b) Shall be separated by a barrier or segregated by adequate spacing from an uninsulated live part connected to a different circuit.

18.4.2 Low-voltage and high-voltage circuits, for example, are considered to be different circuits with reference to the requirement in 18.4.1.

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

18.4.4 A barrier used to provide separation between the wiring of different circuits shall be of metal or of insulating material, of acceptable physical strength if exposed or otherwise likely to be subjected to mechanical damage, and secured 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.

18.4.5 A metal barrier shall have a thickness at least as great as the required 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 to defeat its purpose.

19 Heating Elements

19.1 A heating element shall be securely supported.

19.2 In determining if a heating element complies with the requirement in 19.1, consideration is to be given to sagging, loosening, and other adverse conditions of the element resulting from continuous heating or flexing of the element supports or related wiring due to alternate heating and cooling of the element. See Element Support Impact Tests, Section 51, for tests to be conducted on heating elements.

20 Heating Element Supports

20.1 The supports for an open-type heating element shall be positively secured in position if loosening of the element may result in reduction of electrical spacings between a heating element and a dead metal part. See Spacings, Section 34. The securement of the supports shall not be dependent on tension or pull by the heating element as evaluated by 20.2.

20.2 Element supports are evaluated by assuming an expansion of the heating element from its normal position, to any position that will not cause contact of the element with the exposed dead metal parts. The heater is then moved to various positions in an attempt to dislodge an element support.

21 Electrical Insulation

21.1 Insulating washers, bushings, and the like that are integral parts of a heater, and bases or supports for the mounting of live 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 constructed so that they will have the mechanical strength and rigidity necessary to withstand the stresses of actual service.

21.2 Insulating material employed in a heating appliance is to be judged with respect to its 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 for general use, such as magnesium oxide, may be acceptable if used in conjunction with other less hygroscopic insulating materials or if located and protected so that they are not subject to mechanical damage and are resistant to the absorption of moisture. When it is necessary to investigate a material to determine whether or not it is acceptable, consideration is to be given to its mechanical strength, dielectric properties, insulation resistance (see 48.1), heat-resistant qualities, the degree to which it is enclosed or protected and any other features having a bearing on the likelihood that a risk of fire, electric shock, or injury to persons may occur, under conditions of actual service. All of these factors are considered with respect to thermal aging.

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

22 Thermal Insulation

22.1 Thermal insulation shall be of such nature and located and mounted or supported so that it will not be adversely affected by any intended operation of the heater.

22.2 Thermal insulation that is not rigid shall be mounted or supported so that it will not sag. Adhesive material employed for mounting thermal insulation shall be acceptable for use at the temperature to which it may be subjected.

22.3 Determination of the acceptability of an adhesive may be omitted if the thermal insulation is mechanically supported by at least one rivet or the equivalent per square foot of material (at least 11 rivets or the equivalent per square meter of material).

22.4 Unless it has been investigated for the purpose, flammable thermal insulation or other flammable material is not acceptable if it is located in the heated air stream of a heater.

22.5 Flammable or electrically conductive thermal insulation shall not make contact with uninsulated live parts of a heater.

22.6 Some types of mineral-wool thermal insulation contain conductive impurities in the form of slag that make its use unacceptable if in contact with uninsulated live parts. See 48.1.

23 Materials in an Air-Handling Compartment

23.1 Exposed unimpregnated asbestos material shall not be used in an air handling compartment of a fan-forced air heater. The unprotected edge of a gasket sandwiched between two parts is considered to be exposed.

24 Motors

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

24.2 A motor winding shall be such as to resist the absorption of moisture.

24.3 With reference to the requirement in 24.2, film-coated wire is not required to be additionally treated to resist absorption of moisture, but fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials shall be provided with impregnation or be otherwise treated to resist moisture absorption.

24.4 A rubber or neoprene boot over the terminal of a motor capacitor that is accessible during user-servicing shall not be less than 1/32-inch (0.79 mm) thick, shall resist thermal degradation, and shall incorporate means to secure the boot in place, such as a molded lip that fits over the flange of the capacitor case.

24.5 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 attached to a motor (but not elsewhere in a heater, except as indicated in 24.6) provided that:

- a) The thickness of 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 substances having a deleterious effect on the compound employed.

24.6 A bushing of any of the materials mentioned in 24.5 may be employed at any point in a heater if used with a cord of a type 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 similar.

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

25 Motor Overload Protection

25.1 A fractional-horsepower motor (less than 746 W output) shall be protected by one of the following:

a) An integral thermal protector that provides running overload and locked rotor protection in accordance with the Standard for Overheating Protection for Motors, UL 2111.

Exception: A motor moving air only by means of a fan or blower directly attached to the motor shaft need not be provided with running overload protection.

b) An overcurrent protective device, a temperature limiting control, or a thermal cutoff that in conjunction with the motor complies with the test requirements for Motor Overload and Stalled Motors, 41.10.

c) Impedance protection under the conditions of use in the heater, in accordance with the Standard for Overheating Protection for Motors, UL 2111. The use conditions are to include such factors as elevated ambient due to the heating elements being energized, and restricted ventilation due to the location of the motor in the heater.

25.2 For a multispeed motor that employs a separate overload protective device to provide running protection, the protection is to be effective at all speeds at which the motor is intended to operate.

25.3 An integral-horsepower motor shall be protected by:

a) An integral thermal protector that provides running overload and locked rotor protection in accordance with the Standard for Overheating Protection for Motors, UL 2111, or

b) A motor overload protective device rated or set in accordance with the National Electrical Code, ANSI/NFPA 70.

25.4 A fuse may be used to provide the necessary overload protection if the construction complies with the requirements with the largest-ampere-rated fuse that can be mounted in the fuseholder or with the intended noninterchangeable fuse. The fuse used to provide this protection need not be of a type required for branch-circuit protection, provided the heater is marked in accordance with 64.8.

26 Overcurrent Protection

26.1 General

26.1.1 Overcurrent protection shall be of a type acceptable for branch circuit protection in accordance with the National Electrical Code, ANSI/NFPA 70. The overcurrent protective devices shall be factory installed as an integral part of the heater.

26.1.2 An overcurrent protective device or devices shall be provided for all ungrounded conductors and shall have a voltage rating not less than that of the circuit in which it is used. The device shall be:

a) A circuit breaker acceptable for branch circuit protection;

b) A fuse acceptable for branch circuit protection such as a Class CC, G, H, J, K, L, R, or T cartridge fuse or a Type S plug fuse; or

c) A supplementary type fuse (a type of fuse other than indicated in (b) provided the fuse has a short circuit rating acceptable for the circuit in which it is used. See the Short Circuit Test, Section 43.

The heater shall be marked in accordance with 64.21 – 64.23.

26.1.3 No overcurrent protective device is required as a part of the appliance if equivalent protection will be obtained from the branch-circuit protective device through which the appliance will be supplied.

26.1.4 A fuseholder or circuit breaker shall be rated for the particular application and shall not be accessible from outside the enclosure without opening a door or cover. The operating handle of a circuit breaker may project outside the enclosure. A fuseholder with a removable end cap may have the end cap accessible outside the enclosure. A plug fuseholder shall be so installed that uninsulated live parts other than the screw shell will not be exposed to contact by persons removing or replacing fuses.

26.1.5 Overcurrent protection at not more than 20 amperes shall be provided for each general use duplex receptacle circuit, and for each lampholder circuit independent of a heating element included in the heater, unless the heater is intended for connection to a branch circuit rated at 20 amperes or less.

26.1.6 Overcurrent protection at not more than 15 amperes shall be provided for each general use single receptacle, unless the heater is intended for connection to a branch circuit rated at 15 amperes.

26.1.7 Overcurrent protection for a tapped high-voltage control circuit and for a transformer may be omitted from a heater employing one of the attachment plug configurations shown in Figure 16.1 that is supplied by a branch circuit rated 15 amperes or less, provided the heater conductors, other than the supply cord, do not extend beyond the heater enclosure and are not smaller than No. 18 AWG (0.82 mm²).

26.2 Heating elements

26.2.1 A heater employing resistance type heating elements and rated at more than 48 amperes shall have the heating elements subdivided. Each subdivided circuit shall not exceed 48 amperes and shall be protected at not more than 60 amperes. The current rating of an overcurrent device for a subdivided circuit shall not be less than 125 percent of that circuit current rating.

26.2.2 Air-heating equipment employing infrared heating means shall have overcurrent protection not exceeding 50 amperes.

26.3 Motors and motor-circuits

26.3.1 A motor and motor circuit, except as indicated in 26.3.2, in a heater rated at more than 16 amperes shall be protected by an overcurrent protective device having a maximum ampere rating in accordance with the National Electrical Code, ANSI/NFPA 70. Such short circuit and ground fault overcurrent protection shall be provided as part of the heater unless it can be determined (in accordance with 26.1.3) that equivalent short circuit and ground fault overcurrent protection will be incorporated as an overcurrent protective device in the branch circuit to which the heater will be connected.

26.3.2 The requirement in 26.3.1 does not apply to a motor rated at 1/8 horsepower (93 W output) or less connected to a circuit having overcurrent protection at 50 amperes or less.

26.3.3 A motor having an inherent thermal protector that complies with the requirements for such devices is acceptable with respect to the requirement in 26.3.1 if, in the heater, it will be connected in series with an overcurrent protective device acceptable for branch circuit protection of the same type and having a current rating not more than that with which the motor-protector combination was tested during the investigation of the protector.

26.4 Tapped high-voltage control circuits

26.4.1 For the purpose of these requirements, a tapped high-voltage control circuit is a circuit that is tapped within the heater from the load side of the overcurrent device or devices for the controlled load.

26.4.2 A control circuit that is tapped from the main power supply circuit at a point outside the control equipment enclosure shall be protected as specified in Column A of Table 430-72(b) of the National Electrical Code, ANSI/NFPA 70.

26.4.3 A tapped high-voltage control circuit conductor shall be provided with overcurrent protection. The rating of the overcurrent protective device or devices shall not exceed the applicable value specified in Table 26.1.

Exception No. 1: Overcurrent protection may be omitted as noted in 26.1.7.

Exception No. 2: A No. 18, 16, or 14 AWG (0.82, 1.3, or 2.1 mm²) conductor within the heater enclosure that does not exceed 4 feet (1.2 m) in length between points of opposite polarity may be protected by an overcurrent protective device rated 60 amperes or less.

Exception No. 3: An overcurrent protective device of a higher rating than specified in Table 26.1 may be used provided the conductor complies with the requirements specified in the Short Circuit Tests, Section 43.

Exception No. 4: A lead within the heater enclosure and 12 inches (305 mm) or less in length need not be provided with overcurrent protection.

Exception No. 5: A control circuit conductor supplied from the secondary of a single phase transformer that is connected so that only a 2-wire (single voltage) secondary is used, may be protected by an overcurrent protective device or devices located on the primary side of the transformer provided this protection:

- a) Complies with the requirements for transformer overcurrent protection, 26.5, and*
- b) Does not exceed the applicable value specified in Table 26.1 multiplied by the ratio of secondary to primary rated transformer voltage.*

26.4.4 Overcurrent protection for a tapped high-voltage control circuit conductor shall be provided as part of the heater.

Exception: The overcurrent protective device or devices need not be provided as part of the heater if, based on the marked rating or ratings of the heater, the rating of the branch circuit overcurrent protective device does not exceed the applicable value specified in Table 26.1.

Table 26.1
Overcurrent protective device current ratings for control circuit conductors

Control circuit conductor size, AWG (mm ^b)	Maximum rating of overcurrent protection device, amperes			
	Conductors contained in control equipment enclosure		Conductors extending beyond control equipment enclosure	
	Copper	Aluminum ^a	Copper	Aluminum ^a
18 (0.82)	25	–	7	–
16 (1.3)	40	–	10	–
14 (2.1)	100	–	45	–
12 (3.3)	120	100	60	45
10 (5.3)	160	140	90	75
Larger than 10	b	b	c	c

^a Includes copper-clad aluminum.
^b 400 percent of value specified for 60°C conductors in Table 310-17 of the National Electrical Code, ANSI/NFPA 70.
^c 300 percent of value specified for 60°C conductors in Table 310-16 of the National Electrical Code, ANSI/NFPA 70.

26.5 High-voltage transformers

26.5.1 A transformer (including an autotransformer), other than one as described in 26.1.7 or 26.6.1, is considered to be a high-voltage transformer and shall:

- a) Be provided with thermal overload protection in accordance with 26.5.2,
- b) Be protected by an overcurrent device in accordance with 26.5.4 – 26.5.8, or
- c) Comply with the Burnout Test – High-Voltage Transformers, Section 45.

26.5.2 If a high-voltage transformer is provided with a thermal overload protective device, the device shall be arranged to interrupt the primary circuit. The device and the transformer are to be subjected to one of the following tests:

- a) If the device is other than a nonrenewable thermal cutoff type, the Overload Test – High-Voltage Transformers, Section 44; or
- b) If the device is a nonrenewable thermal cutoff type, the Burnout Test – High-Voltage Transformers, Section 45.

26.5.3 A thermal cutoff that is used to provide thermal overload protection shall comply with the Standard for Thermal Cutoffs for Use in Electrical Appliances and Components, UL 1020. A manual or automatic reset thermal protector shall have an endurance rating of not less than 6000 cycles when tested in accordance with the Endurance Test, Section 42, and shall comply with the requirements for the calibration of temperature limiting controls in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873.

26.5.4 If a high-voltage transformer is protected by an overcurrent device, such protection shall comply with the requirements specified in 26.5.5 – 26.5.8.

26.5.5 Except as noted in 26.5.6 – 26.5.8, a high-voltage transformer shall be protected by an overcurrent device or devices, located in the primary circuit and rated not more than 15 amperes or 125 percent of the rated transformer primary current, whichever is greater.

26.5.6 Overcurrent protection located in the primary circuit of a transformer need not be provided as part of the heater if based on the marked rating of the heater, the rating of the branch circuit overcurrent protective device does not exceed the applicable value specified in 26.5.5. See 64.24.

26.5.7 For other than an autotransformer, additional overcurrent protection is not required in the primary circuit if the circuit supplying the transformer is provided with overcurrent protection rated or set at not more than 250 percent of the rated primary current of the transformer and the secondary circuit is protected by a protective device that is provided as part of the heater and is rated, or set, at not more than 15 amperes or 125 percent of the rated transformer secondary current, whichever is greater, except as noted in 26.5.8. See 64.21 – 64.24.

26.5.8 If 125 percent of the current does not correspond to a standard rating of fuse or circuit breaker, the next higher standard rating may be used. Standard ratings are 15, 20, 25, 30, 35, 40, 45, 50, and 60 amperes.

26.6 Low-voltage transformers

26.6.1 Except as indicated in 26.6.2, a transformer having a rated output of not more than 30 volts and 1000 volt-amperes (National Electrical Code, ANSI/NFPA 70, Class 1, power-limited circuit) shall be protected by an overcurrent device located in the primary circuit. The overcurrent device shall be rated or set at not more than 15 amperes or 167 percent of the primary current rating of the transformer, whichever is greater.

26.6.2 A transformer that directly supplies a Class 2 circuit shall, in accordance with the Standard for Class 2 and Class 3 Transformers, UL 1585, either limit the output current (inherently limited transformer) or be equipped with an overcurrent device (not inherently limited transformer), and need not comply with the requirements in 26.6.1.

27 Secondary Circuits

27.1 General

27.1.1 Each secondary circuit is to be judged under the requirements for line-voltage circuits.

Exception: A secondary circuit need not be investigated if:

- a) It is not a circuit which is designed to prevent unintended operation of a heater, and*
- b) It complies with the requirements for a limited-energy-secondary circuit as described in 27.2.*

27.1.2 Secondary circuits may be connected to the frame of the appliance. Except as noted in 27.1.3 and 27.2.6, the connection shall be made at only one point in the appliance or system.

27.1.3 A grounding bus of adequate ampacity that is used as the return for a secondary circuit other than as covered by 27.2.6 may be connected to the frame at more than one point.

27.1.4 If any secondary circuit having an open-circuit potential of more than 42.4 volts peak is connected to the frame of an appliance, all exposed dead metal parts that might become energized, and all dead metal parts within the enclosure that can be touched by a person during operator servicing and that might become energized, shall be reliably connected together.

27.2 Limited-energy-secondary circuits

27.2.1 A limited-energy-secondary circuit shall be supplied from:

- a) Class 2 transformer, or
- b) An isolating transformer having an open-circuit sinusoidal potential of 30 volts, rms (42.4 volts peak) or less, and that includes at least one of the following means, that limits the power available to the levels specified for a Class 2 transformer.
 - 1) A reliable fixed impedance;
 - 2) A noninterchangeable fuse – the largest fuse that fits in the fuseholder provided;
 - 3) A nonadjustable manually reset circuit protector; or
 - 4) A reliable regulating network.

27.2.2 The impedance, the fuse, the protector, or the regulating network and the wiring between them and the isolating transformer described in 27.2.1 shall be judged as if they were part of a line-voltage circuit.

27.2.3 A fuse or a circuit protector used to limit the power as specified in 27.2.1 shall be rated or set at not more than 3.2 amperes for a circuit operating between 15 and 30 volts and at not more than 5.0 amperes for a 0 – 15-volt circuit.

27.2.4 An impedance or a regulating network that is used to limit the current shall be of such value or design as to limit the current under short-circuit conditions to not more than 8.0 amperes measured after 1 minute.

27.2.5 The performance of a regulating network or fixed impedance used to limit the power in accordance with 27.2.1 shall not be adversely affected by either short circuit or open circuit between any two terminals of any single rectifier, capacitor, transistor, or similar component in the network.

27.2.6 The frame may be used as the return for a limited-energy-secondary circuit.

27.2.7 The wiring in a limited-energy-secondary circuit shall be acceptably routed away from the wiring of other circuits or shall be provided with insulation that is for use at the highest of the voltages in the other circuits.

27.2.8 The wiring in a limited-energy-secondary circuit shall be acceptably routed away from the uninsulated live components of other circuits.

27.2.9 Wires and cables that are part of a limited-energy-secondary circuit shall be provided with strain relief in accordance with 16.11 – 16.13 and the Strain Relief Test, Section 58, if stress on the wire or cable could cause the internal wiring of the circuits to contact uninsulated live parts of other circuits.

28 Temperature Limiting Controls

28.1 With respect to the Normal Temperature Test, Section 39, and Abnormal Operation Tests, Section 41, if operation of the heater in accordance with Subsection 39.2 could result in a risk of fire or electric shock due to overheating of the heater, a thermal cutoff or a manual reset type temperature limiting control shall be provided. The manual reset type temperature limiting control shall be of a type that will not operate as an automatic reset control when the reset means is held in the reset position.

Exception: An automatic reset type temperature limiting control or a manual reset type temperature limiting control that operates as an automatic reset type when the reset means is held in the reset position may be used as a control to limit temperatures for the heaters specified in (a) – (d) below.

a) For a heater that complies with the abnormal ambient test, 41.9, and is provided with an alarm in accordance with Alarms, Section 29.

b) For a heater in which the average "on" time per cycle over four cycles of operation on the temperature limiting control during each abnormal operation temperature test does not exceed 5 percent and the average "on" time does not exceed 1 minute. The control used shall withstand an endurance test consisting of 100,000 cycles of operation making and breaking its rated load.

c) For a heater in which the manual reset control reset means is arranged such that it:

1) Is recessed within the overall appliance enclosure,

2) Cannot be forced to remain in the reset position by likely methods, such as taping down a pushbutton or wedging a pushbutton in an opening through which it protrudes, and

3) Is not jammed in the reset position during the Element Support Impact Tests, Section 51 and Drop Test, Section 52, or

d) For a commercial/industrial heater.

28.2 A thermal cutoff shall be secured in place. A thermal cut-off that is field-replaceable shall be used only in a commercial/industrial heater.

28.3 If an appliance is provided with a replaceable overcurrent and/or over-temperature protective device, the device shall be secured in place and shall be so located that it will be accessible for replacement without damaging other connections or internal wiring. See 64.5.

28.4 A thermal cutoff shall open 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 heater is connected to a circuit of voltage in accordance with 39.1.9 and operated in a normal position to cause abnormal heating.

28.5 To determine if a thermal cutoff complies with the requirement in 28.4, the heater is to be operated with separate cutoffs five times with any other thermally operated control devices in the heater short-circuited. Each cutoff is required to perform acceptably. During the test, the enclosure is to be connected through a 3-ampere fuse to ground.

Exception: If the thermal cutoff complies with the Standard for Thermal Cutoffs for Use in Electrical Appliances and Components, UL 1020, this test does not have to be conducted.

28.6 With respect to 28.4, for heaters employing open-type heating elements or series-connected metal-sheathed heating elements, thermal cutoffs shall be used in all ungrounded supply conductors if the thermal cutoff in one side of the supply circuit could be rendered ineffective by faults such as shorting of the heating element or its connection wire to metal parts that are or may become grounded. In determining the likelihood of occurrence of such a fault, conditions such as sagging or breakage of an open-type heating element and breakage or loosening of the connection to a heating element are to be considered. For a 120-volt heater with an unpolarized plug, both sides of the supply circuit are to be considered as being ungrounded.

28.7 A temperature-limiting control that is depended upon to reduce a risk of fire or electric shock shall be a calibrated control that is either:

- a) A control complying with the Standard for Limit Controls, UL 353, or
- b) A temperature-limiting control complying with the Standard for Temperature-Indicating and -Regulating Equipment, UL 873.

See the Endurance Test, Section 43, also.

29 Alarms

29.1 A heater as specified in (a) of exception to 28.1, or a heater employing an automatically reset auxiliary temperature control, shall include an audible or visual alarm to indicate that one or more controls has operated. The alarm shall become energized when an abnormal ambient condition occurs and a control functions to de-energize the heater. If the control functions to reenergize the heater the alarm may be de-energized or it may remain energized until it has been de-energized manually.

Exception: A heater employing an automatically reset auxiliary temperature control need not be provided with an alarm if the heater complies with 39.1.1 (normal temperature tests) when operated with the auxiliary temperature control operational and with the temperature limiting control bypassed under the abnormal operation conditions specified in 41.2 – 41.12.

29.2 An audible alarm shall consist of a sounding device such as a buzzer, horn, beeper, or bell that generates a continuous distinct signal while it is energized. The alarm shall comply with the Alarm Device Endurance Test, Section 40.

29.3 A visual alarm shall consist of a light that is red and of a different color than the lamp used in the "power on" pilot light (see 31.1) or of a flashing indicator light that has an "on" time not less than one third of the "off" time and that cycles on and off at least 15 times a minute. The light shall be constructed and located as specified in 31.1 and it shall comply with the visibility requirements in 31.2. The lamp used in the indicator light shall have a minimum rated life of 20,000 continuous hours at rated voltage, or it shall withstand the test specified in the Alarm Device Endurance Test, Section 40.

29.4 The "Important Instructions" furnished with a heater that includes an alarm shall include instructions in accordance with of 65.2.1(16).

30 Lampholders

30.1 If a heater is equipped with a polarized attachment plug, a lampholder supplied as a part of the heater shall be wired so that the screw shell will be connected to the identified grounded conductor.

30.2 Except as noted in 30.3, a lampholder shall be installed so that uninsulated live parts, other than the screw shell, will not be exposed to contact by persons removing or replacing lamps.

30.3 The requirement in 30.2 does not apply if, in order to remove or replace a lamp, it is necessary to dismantle the heater by means of tools. See 64.5.

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

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

31 Pilot Lights

31.1 A movable heater shall be provided with a pilot light having a lamp or lens that glows red or amber. The light shall:

- a) Be located on the front or top surface of the heater; and
- b) Comply with 31.2.

The light shall be connected to the heater circuit so that it is energized whenever the on-off switch (see 32.12) is in the on position. Compliance of the light shall be determined only when the on-off switch is in the on position.

Exception No. 1: A pilot light is not required if a visibly glowing heating element can be considered to serve as an indicator that the heater is energized. A heating element is considered to serve as an indicator if:

- a) The heating element for the heater consists of a single element,*
- b) The element is not cycled by an automatic control,*
- c) The element cannot be operated by either a manual or automatic control, at a reduced rating so, that it can no longer be considered a visibly glowing element in accordance with 3.15, and*
- d) The heater complies with the visibility requirement of 31.2.*

Exception No. 2: A pilot light is not required on a commercial/industrial heater.

31.2 The light from a pilot light mentioned in 31.1 shall be visible from a point 10 feet (3 m) in front of the center of the heater and 5 feet (1.5 m) above the floor. Compliance with this requirement shall be determined while the heater is:

- a) Standing on the floor if the heater is intended for placement on the floor while in operation, or
- b) Elevated from the floor by 3 feet (0.91 m) if the heater is intended for use at an elevated location (see 3.6).

For a heater intended to be used either on the floor or at an elevated location, the light shall be visible while the heater is mounted on the floor and also when it is elevated by 3 feet.

32 Switches

32.1 A switch or other control device shall be rated for the particular application and shall have a current and voltage rating not less than that of the circuit (load) which it controls.

32.2 A switching device shall be so located or protected that it will not be subjected to physical damage in use.

32.3 A switching device or manual mode control shall be of the indicating type or the switch function, such as "on-off", "high-low", and the like, shall be otherwise indicated. The switch or manual control position indications shall be visible when the heater is located and positioned in the intended use position.

Exception: For a movable heater that may be used in an elevated location, the markings of manual control positions need not be visible for the following controls when the heater is located higher than 2.5 feet above the floor:

- a) For a control whose sole function is to regulate the fan speed or the heat output.*
- b) For a direct-acting on-off control whose actuation position to and from the off position becomes immediately evident to the operator through perception of change in the heater output.*

32.4 For a movable heater of other than the commercial/industrial type that employs a fan only operating control and that is unlikely to be moved to view the controls when operating the controls, the indications for the fan only selection position and the various heat selector positions shall be visible from a point 5 feet (1.5 m) above the floor and between 1 and 4 feet (0.3 and 1.2 m) away from the front surface of the heater with the lower edge of the heater located at any point between and including 2.5 and 5 feet (0.75 and 1.5 m) above the floor. Heaters complying with the dimensions of 3.6 are considered as likely to be moved to view the control markings when operating the control.

32.5 If a switching device (or the pilot device that controls the switching device) has a marked on or off position, when open, it shall disconnect all ungrounded conductors of the power-supply circuit to a heater. See 32.6 and 32.7.

32.6 With respect to 32.5, 32.7, and 32.14, for a 120-volt rated heater having a two-prong unpolarized attachment plug, both sides of the supply circuit are to be considered as being ungrounded.

32.7 A switching device as described in 32.5, except that it does not have a marked on or off position, shall comply with the requirement in 32.5 unless:

- a) There is no uninsulated live part exposed to unintentional contact when the switching device is open, or
- b) The fact that such part is live is definitely apparent, such as a visibly glowing open coil heating element.

32.8 With respect to 32.3 and 32.5, a removable knob, button, or pointer on a switching device that includes an indicated off position shall be keyed to its operating shaft so that it can be installed only in the intended position and it shall be secured in accordance with Knob Securement Test, Section 55.

32.9 A switching device 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 readily change the connections to provide for the use of more elements than intended.

32.10 A switching device that controls a medium-base lampholder or other than a pilot or indicating light shall be rated for use with tungsten-filament lamps.

32.11 A heater shall be provided with means other than the cord and plug arrangement to manually interrupt all heating elements. This means may be either a manual on-off switch or included as an off position on a temperature regulating control or an operation selector switch. The switch or control used shall comply with 32.1 – 32.10. If included as an off position on a temperature regulating control or on an operation selector switch, the construction shall also comply with 32.12. See also 31.1.

32.12 With respect to 32.11, if the off position is included as part of a temperature operating control or an operation selector switch, the off position shall be mechanically defined, such as by a detent feature or as an extreme position against a mechanical stop.

32.13 A heater intended for connection to the power-supply circuit by flexible cord and an attachment plug, and a cord-connected heater employing a motor rated at more than 1/3 horsepower (249 W output) shall be provided with a manually operable motor-control switch.

32.14 A switching device on a heater that controls an open (uninsulated) heating element or an isolated metal-clad element in a grounded heater shall be such that, in the off position, it will disconnect the element from all conductors of the supply circuit, unless the guard is such that it complies with 10.1.6.

32.15 The requirement in 32.14 also applies to a through-cord switch and to a plug with switch comprising a part of a cord set provided with the heater or of a power-supply cord.

32.16 A through-cord switch used on the power supply cord of a floor supported heater shall not be located where there is a likelihood of the switch resting upon the floor and being stepped on.

32.17 A through-cord switch used on a wall-hung or ceiling-hung heater shall be located on the power-supply cord so that it does not contact the floor when the heater is installed as intended.

32.18 A switch employed in a heater to de-energize the heating elements in the event the heater is tipped over shall function before the heater has tipped in any direction beyond the angle of critical balance (see 3.2) if compliance with the requirements in 41.4.1 – 41.4.4 is dependent on operation of the switch.

33 Automatic Controls and Control Circuits

33.1 General

33.1.1 A control circuit shall comply with the requirements for separation of circuits, 18.4.

33.1.2 If a temperature and/or mode control in a heater has a marked off position, it shall disconnect the element or elements it controls from all ungrounded conductors of the power-supply circuit when placed in that position (that is, when not cycling). See 33.1.3 and 33.1.4.

33.1.3 A control as described in 33.1.2, except that it does not have a marked off position, shall comply with the requirement in 33.1.2 unless:

- a) There is no uninsulated live part exposed to unintentional contact when the control device has opened the circuit, or

b) The fact that such part is live is definitely apparent.

33.1.4 A temperature and/or mode control in a heater that controls an open (uncovered) heating element or an isolated metal-clad element in a grounded heater shall be such that, in the off position, it will disconnect the element from all conductors of the supply circuit, unless the guard is such that it complies with one of the following:

a) No opening in the guard will permit passage of a rod having a diameter of 3/8 inch (9.5 mm).

b) No opening in the guard will permit passage of a rod having a diameter of 3/4 inch (19.1 mm) and no uninsulated live part or isolated metal-clad element is less than 4 inches (102 mm) from the nearest point on the guard at any opening that will permit the entrance of a rod having a diameter of 3/8 inch.

33.1.5 When provided, a safety control – one designed to prevent unintended operation of a heater – or a temperature limiting control shall be operative whenever the heater is connected to its power supply and shall interrupt power to all heating elements. (See 33.1.6). If the power to all elements is not interrupted, the power shall be interrupted to the number of the heating elements necessary so that the temperature rises specified in Table 39.1 are not exceeded during abnormal tests.

33.1.6 With respect to 33.1.5, for heaters employing open-type heating elements or series-connected sheathed heating elements, a temperature limiting control shall interrupt power to all ungrounded supply conductors if the thermal cutoff or the control contacts in one side of the supply circuit could be rendered ineffective by faults such as shorting of the heating element or its connecting wire to metal parts that are or may become grounded. In determining the likelihood of occurrence of such a fault, conditions, such as sagging or breakage of an open-type heating element and breakage or loosening of the connection of a lead wire to a heating element, are to be considered. For a 120-volt heater with an unpolarized plug, both sides of the supply circuit are to be considered as being ungrounded. More than one temperature-limiting control may be used to comply with this requirement.

33.1.7 A contactor actuated by a temperature limiting control shall comply with the requirements for such a control.

33.1.8 If a temperature and/or mode control has a marked position as described in 33.1.9, it shall not function as a temperature and/or mode control – that is, it shall not respond to temperature changes – while the actuating member is in that position.

33.1.9 The requirement in 33.1.8 applies to a temperature and/or mode control that is marked:

a) With an off position, or

b) With another wording (such as "no heat ", "cold ", or similar wording) that conveys the same meaning as the word "off ".

33.1.10 A temperature regulating control that does not reclose (remains open) when cooled to a temperature of minus 35°C (minus 31°F) is acceptable with respect to the requirement in 33.1.8.

33.2 Terminals and actuating members of safety and temperature limiting controls

33.2.1 The terminals of a safety control and temperature limiting controls within the enclosure of a heater shall be so located or further enclosed that they will be protected against unintentional short-circuiting or damage.

33.2.2 The bulb, capillary tubing, or other sensing element of a temperature limiting control shall be so located or guarded as to be protected from physical damage during installation and use of the heater.

34 Spacings

34.1 Except as noted in 34.2 and 34.3, the spacings in a heater shall be in accordance with Table 34.1.

34.2 The spacings specified in Table 34.1 do not apply to the inherent spacings of a component part, such as a snap switch or motor, of a heater. Such spacings are judged under the requirements for the component in question.

34.3 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 heater rated at 250 volts or less. Within a temperature control, except at contacts, the spacing between uninsulated live parts on opposite sides of the contacts is not to be less than 1/32 inch (0.8 mm) through air and 3/64 inch over the surface of insulating material, and the construction is to be such that the spacings will be maintained permanently.

34.4 The spacings within a motor connected across a portion of a resistance element or in series with a reactor or an autotransformer shall be acceptable for the full rated voltage of the heater.

34.5 Except as indicated in 34.6, an insulating lining or barrier of fiber or similar material employed where spacings would otherwise be less than the required values shall not be less than 1/32 inch (0.8 mm) thick and shall be so located or of such material that it will not be affected adversely 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.

34.6 Insulating material having a thickness less than that specified in 34.5 may be used if, upon investigation, it is found to be acceptable for the application.

34.7 Unless protected from physical abuse during assembly and operation of the heater, a barrier of mica shall be at least 0.01 inch (0.25 mm) thick.

Table 34.1
Minimum acceptable spacings through air or over the surface ^a

Parts involved	Potential involved, volts	Inch	mm
A. Between uninsulated live parts of opposite polarity; and between a rigidly mounted uninsulated live part other than an open-type heating element (see below) and a noncurrent-carrying 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}
B. Between an open-type heating element and a noncurrent-carrying metal part that either is exposed for persons to contact or may be grounded, except for a temperature limiting control sensing element and its supports located above the heating elements. ^{d,e,f}	0 – 600	1/2	12.7
<p>^a If an uninsulated live part is not rigidly supported, or if a movable noncurrent-carrying 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. In applying this table, a sheath of an isolated metal-clad element in a heater with provisions for grounding is considered to be an uninsulated live part.</p> <p>^b Film-coated 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 noncurrent-carrying metal part and film-coated insulated wire rigidly supported and held in place on a motor coil.</p> <p>^c A spacing of 1/16 inch (1.6 mm) is permissible at the heating element support and terminals only (see note d) in a heater rated for 300 volts or less.</p> <p>^d These spacing requirements apply to an open-type heating element such as a ribbon type or a coiled type at locations other than the element supports and its terminal connections. At each element support and within 1/2 inch (12.7 mm) of the support, measured from the outer edge of the support point along the heater element, and at the terminal connections, the spacings specified in item A apply provided the element supports are constructed such that sagging of the heating element due to loss of its tension will not result in reduction of the minimum spacings as specified in the item A.</p> <p>^e For the temperature limiting control sensing element and its supports located above the heating element, the spacing requirements in item A apply. A sensing element and its supports are considered to be above the heating element if any sag in the heating element due to gravity would result in an increased spacing between the heating element and the sensing element or its supports.</p> <p>^f Less than a 1/2-inch spacing between the open-type heating element and a noncurrent carrying metal part, but not less than the spacing specified in item A, is acceptable if the design of the heating element and its supports is such that sagging or movement of the heating element, to reduce the spacing to less than specified in item A, is not likely to occur.</p>			

35 Grounding

35.1 A heater intended for operation on a circuit involving a potential of more than 150 volts to ground shall have provision for grounding, in accordance with 35.2, of all exposed noncurrent-carrying parts, and all noncurrent-carrying metal parts exposed during any servicing operation (including maintenance and repair), that are likely to be energized.

35.2 On a heater where grounding is required or provided, the power-supply cord or cord set shall include a grounding conductor which shall be:

- a) Green, with or without one or more yellow stripes,
- b) Connected to the grounding blade of an attachment plug of a grounding type, and
- c) Connected to the enclosure of the appliance by means of a screw not likely to be removed during ordinary servicing, or by other equivalent means. Solder alone is not acceptable for making this connection. See 35.4.

35.3 If a heater intended for operation on a circuit involving a potential of 150 volts or less to ground has provision (although not required) for grounding noncurrent-carrying metal parts by means of a conductor of the cord, a directly attached flexible cord or a cord set provided with the heater shall comply with the requirement in 35.2.

35.4 With reference to 35.2(c), a grounding connection that is mechanically crimped before being soldered is to be tested for acceptability as a connection without the solder in place.

35.5 A 2-wire heater, having a voltage rating within the range of 220 to 250 volts is considered as requiring provision for grounding in accordance with 35.1, unless the marked rating on the heater is 120/240 volts or unless the heater is otherwise marked to indicate that it is to be connected only to a 120/240-volt circuit with grounded neutral.

PERFORMANCE

36 General

36.1 If a heater is intended to be shipped with the legs or base detached, the tests are to be conducted with the legs or base in place, as well as detached.

Exception No. 1: The requirement for tests with the legs or base detached is not applicable to a heater that will not stand upright without the base or legs installed and is obviously intended for operation in the upright position, or to a heater that cannot be operated with the legs or base detached.

Exception No. 2: The requirement for tests with the legs or base detached is not applicable to a heater that is marked in accordance with 64.19.

37 Power Input Test

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

37.2 To determine if a heater complies with the requirement in 37.1, the power input is to be measured at the temperature developed under intended operating conditions and under full-load conditions and while connected to a supply circuit of rated voltage in accordance with 39.1.9. If a heater employs a nonmetallic element (such as carbon), the power input is to be determined when the element is new.

38 Leakage Current Test

38.1 The leakage current of a heater rated for a nominal 120-, 208-, or 240-volt supply when tested in accordance with 38.3 – 38.6 shall not be more than:

- a) 0.5 milliamperes for a movable heater, and
- b) 0.75 milliamperes for other than a movable heater employing a standard attachment plug rated 20 amperes or less.

Exception: For a heater having a metal sheathed heating element, during the period beginning 5 seconds after energization (closure of S_1), the leakage current may exceed the value specified in (a) or (b) for a period not exceeding 5 minutes, but shall not exceed 2.5 milliamperes. The 5-minute period is measured during the warm-up period and again during the cool-down period from the first excursion above the value of (a) or (b) until the value is less than and remains less than the value in (a) or (b).

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

38.3 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from the 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 the risk of electric shock as defined in 8.1 – 8.10. Surfaces are considered to be simultaneously accessible where 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 voltages which are considered to be nonhazardous.

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

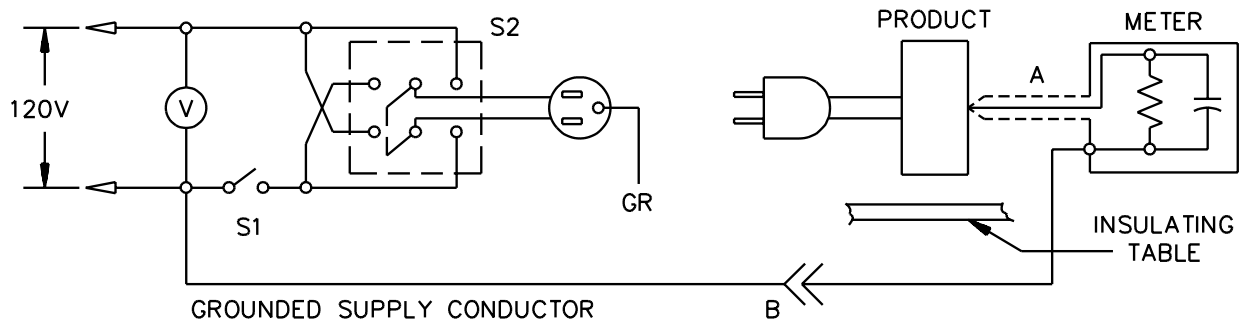
38.5 The measurement circuit for leakage current is to be as shown in Figure 38.1. The measurement is defined in (a) through (d). The meter which is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used need not have all the attributes of the defined instrument.

- a) The meter is to have an input impedance of 1500 ohms resistive shunted by a capacitance of 0.15 microfarad.
- 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 to 100 kilohertz the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) equal to the ratio of the impedance of a 1500 ohm resistor shunted by 0.15 microfarad capacitor to 1500 ohms. At an indication of 0.5 or 0.75 milliampere, the measurement is to have error of not more than 5 percent.
- d) Unless the meter is being used to measure leakage from one part of a heater to another, the meter is to be connected between the accessible parts and the grounded supply conductor.

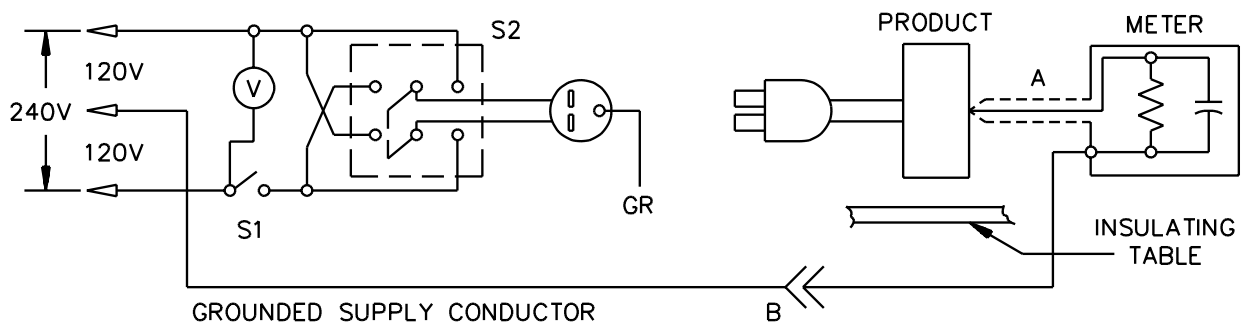
38.6 A representative heater is to be tested for leakage current starting with the as-received condition with all switches and temperature controls closed, but with its grounding conductor, if any, opened at the attachment plug. The as-received condition is without prior energization, except as may occur as part of the production line testing. The supply voltage is to be 120, 208, or 240 volts, depending upon the voltage rating of the heater. The test sequence, with reference to the measuring circuit (Figure 38.1), is to be as follows:

- a) With switch S1 opened, the heater 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 heater, and within a period of 5 seconds, the leakage current is to be measured using both positions of switch S2 and with the heater operated at the maximum heat setting of controls.

Figure 38.1
Leakage-current measurement circuit



Product intended for connection to a 120-V power supply



Product intended for connection to 240 or 208 volt power supply

A - Separated and used as a clip when measuring currents from one part to another.

B - Probe with shielded lead - Under some circumstances where higher frequency components are present, shielding of the measuring instrument and its leads may be necessary.

LC300P

c) Leakage current is to be monitored until thermal stabilization under the maximum heat condition. Both positions of switch S2 are to be used. The equivalent of thermal stabilization is considered to be obtained as in any normal temperature test. If any temperature control does not cycle at the maximum heating setting, it is to be adjusted until it does cycle before the final measurements at thermal stabilization are taken. Measurements are to be made with the temperature control, if any, open and closed.

d) If the heater employs a single pole switch or a adjustable temperature control, monitoring of leakage current is to continue until the leakage current stabilizes or decreases after the heater is turned off.

39 Normal Temperature Tests

39.1 General

39.1.1 A heater, when tested under the conditions described in 39.1 – 39.3 shall not attain a temperature at any point high enough to constitute a risk of fire or damage any material employed in the heater, nor show temperature rises at specific points greater than those indicated in Table 39.1.

39.1.2 All values in Table 39.1 are based on an assumed ambient (room) temperature of 25°C (77°F), but a test may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F). However, if the operation of an automatic reset temperature control during the test limits the temperatures under observation, no observed temperature higher than 25°C (77°F) plus the specified maximum rise is acceptable.

Table 39.1
Maximum acceptable temperature rises

Materials and component parts		°C	°F
1.	Any point on a surface adjacent to a wall-hung heater or ceiling-hung heater (including the surface on which the heater is hung), specified points on test surfaces and enclosures at designated clearances from the heater, a metal surface of a heater at the point of contact with the test surface, and the exterior surface of a recessed heater that may come into contact with combustible material within the test enclosure.	65	117
2.	Fuses ^a	65	117
3.	Fiber used as electrical insulation or as cord bushings.	65	117
4.	Wood or other combustible material that is part of the heater.	65	117
5.	Cotton or rayon braid of a flexible cord.	65 ^b	117 ^b
6.	Class 105 insulated relay or solenoid winding	65 ^c	117 ^c
7.	Class A insulation system on coil windings of an a-c motor having a frame diameter (see note d) of more than 7 inches (178 mm) and of a d-c universal motor ^e .		
	a. In an open motor:		
	Thermocouple method	65	117
	Resistance method	75	135
	b. In a totally enclosed motor:		

Table 39.1 Continued on Next Page

Table 39.1 Continued

Materials and component parts		°C	°F
	Thermocouple method	70	126
	Resistance method	80	144
8.	Class A insulation systems on coil windings or an a-c motor (not including a universal motor) having a frame diameter (see note d) of 7 inches (178 mm) or less and on a vibrator coil – thermocouple or resistance method ^C .		
	a. In an open motor and on a vibrator coil	75	135
	b. In a totally enclosed motor	80	144
9.	Class 130 insulation systems, except as indicated in items 10 and 11:		
	Thermocouple method ^C	85	153
	Resistance method	105	189
10.	Class B insulation systems on coil windings of an a-c motor having a frame diameter (see note d) of more than 7 inches (178 mm) and of a d-c or universal motor ^e :		
	a. In an open motor:		
	Thermocouple method	85	153
	Resistance method	95	171
	b. In an totally enclosed motor:		
	Thermocouple method	90	162
	Resistance method	100	180
11.	Class B insulation systems on coil windings of an a-c motor (not including a universal motor) having a frame diameter (see note d) of 7 inches or less and on vibrator coils– thermocouple or resistance method ^e :		
	a. In open motors and on vibrator coils	95	171
	b. In totally enclosed motors	100	180
12.	Phenolic composition used as electrical insulation or where degradation would result in risk of fire or electric shock condition ^f	125	225
13.	For a movable heater other than a wall- or ceiling-hung heater as covered by item 1, points on supporting surface and test alcove side wall surfaces	125	225
14.	Insulated wire or cord	25°C or 45°F less than its accepted temperature rating	
15.	Sealing compound ^h		
16.	Copper conductor, bare or insulated, without tinning, nickel coating, or silver plating or otherwise protected, except as noted in item 17.	175	315
17.	Termination of copper conductor in a pressure terminal connector:		
	a. Terminal and/or conductor unplated	125	225
	b. Terminal and conductor tinned, nickel-coated, or silver-plated	175	315
18.	Points on handles, switches, and control knobs and buttons likely to be contacted by the user during normal operation, and the surfaces likely to be contacted by hands or fingers in grasping handles, switches, and control knobs and buttons:		
	a. Metal	35	63

Table 39.1 Continued on Next Page

Table 39.1 Continued

Materials and component parts		°C	°F
b. Nonmetallic		60	108
19.	Surfaces of heaters that employ confined heat transfer fluid which are accessible to a 3 inch (76.2 mm) diameter probe of unrestricted length having a hemispherical end.	130	234
20.	Power diode case (body)	k	k
21.	Heat Transfer Fluid	l	l
<p>^a Includes both casing and ferrule. However, a temperature not more than 20°C (36°F) higher than the values indicated in the table is acceptable on the casing (not the ferrule) of a class G, J or T fuse.</p> <p>^b Inside a heater, the braid of a heater cord may be subjected to a greater rise if the inorganic fiber insulation is held in place by other acceptable means.</p> <p>^c A maximum rise of 85°C (153°F) is acceptable by the resistance method.</p> <p>^d This is the diameter, measured in the plane of the laminations, of the circle circumscribing the stator frame, excluding lugs, fins, boxes, and similar parts, used solely for motor mounting, cooling, assembly, or connection.</p> <p>^e See 39.1.6 and 39.1.7.</p> <p>^f The limitation on phenolic composition does not apply to a compound which has been investigated and found to have heat-resistant properties.</p> <p>^g Inside a heater, 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 a braid, wrap, tape, or close-fitting tubing) which is acceptable for the temperature and type of insulation involved.</p> <p>^h Unless a thermosetting material, the maximum sealing-compound temperature, when corrected to a 25°C (77°F) ambient temperature is 15°C (27°F) less than the softening point of the compound as determined by the ball and ring apparatus as described in the Standard Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus, ASTM E 28-99.</p> <p>ⁱ Surfaces likely to be contacted are considered to be those within 1-1/2 inches (38 mm) of the gripping surface of a knob or button, measured in the same plane as the surface on which the knob or button is mounted, except that the surface behind the knob or button is not considered likely to be contacted if:</p> <ol style="list-style-type: none"> 1) The knob or button is at least 1 inch (25.4 mm) long, including the shaft extension, or 2) If a knob or a button less than 1 inch long is provided with a skirt or flange at the base of its gripping surface that is at least 1/4 inch (6.4 mm) wide. The gripping surface for a carrying handle is considered to be 4 inches (102 mm) wide, and surfaces likely to be contacted are considered to be those within 1-1/2 inch, in any direction of the gripping surface of the handle. Points and surfaces guarded by a barrier that is at least 5/8 inch (15.9 mm) wide are not considered likely to be contacted provided the temperature rise of the barrier does not exceed the required values. <p>^j A knob, handle, or button made of nonmetallic material that is plated or clad with metal having a thickness of 0.005 inch (0.13 mm) or less and a metal knob, handle, or button having a plastic or vinyl covering of not less than 0.005 inch thickness is to be judged as a nonmetallic part.</p> <p>^k This temperature rise on a power diode shall not exceed the difference between the ambient and the temperature rating specified for the diode by the diode manufacturer. If no temperature rating is specified for the power diode, the maximum acceptable temperature rise shall not exceed 65°C (117°F).</p> <p>^l This temperature rise shall not exceed the difference between the ambient and the temperature rating specified by the manufacturer. The maximum temperature shall not exceed the flash point.</p>			

39.1.3 Temperatures are to be measured by thermocouples consisting of wires not larger than No. 24 AWG (0.21 mm²) and not smaller than No. 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 (see 39.1.6). When thermocouples are used in determining temperatures in electrical equipment, it is

standard practice to employ thermocouples consisting of No. 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 thermocouple are necessary.

39.1.4 The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice. The thermocouple wire is to conform with the requirements specified in the Initial Calibration Tolerances for Thermocouples table in Temperature Measurement Thermocouples, ANSI/ISA MC96.1.

39.1.5 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, acceptable 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.

39.1.6 Ordinarily a thermocouple is to be used for determining temperature of a coil or winding if it can be mounted, without removal of encapsulating compound or similar material, on the integrally applied insulation of a coil without a wrap, or on the outer surface of a wrap that is not more than 1/32 inch (0.8 mm) thick and consists of cotton, paper, rayon, or the like (but not of asbestos or similar thermal insulation). The change-of-resistance method is to be used if the thermocouple measurement cannot be conducted in accordance with the foregoing considerations. For a thermocouple-measured temperature of a motor coil the thermocouple is to be mounted on the integrally applied insulation of the conductor.

39.1.7 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 39.1 if the temperature rise of the coil measured by the resistance method is not greater than specified in Table 39.1:

Items in Table 39.1	Additional Thermocouple Rise	
Item 6 and part a of item 7	15°C	(27°F)
part a of item 8	5°C	(9°F)
part a of item 10	20°C	(36°F)
part a of item 11	10°C	(18°F)

39.1.8 To determine whether a heater complies with the requirement in 39.1.1, it is to be operated continuously until constant temperatures have been reached. A temperature is considered to be constant when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test (but not less than 5-minute intervals), indicate no change.

39.1.9 The test voltage is to be as indicated in Table 39.2, except that, if the application of the indicated test voltage does not result in the measured wattage input to the heater being equal to or more than the marked wattage rating, the test voltage is to be increased until the measured wattage input equals the marked wattage rating.

Table 39.2
Voltage for temperature test^a

Marked voltage rating	Test potential in volts
Value within one of the specified ranges	Highest value of corresponding specified ranges
Value not within one of the specified ranges	Rated voltage
^a Specified range refers to any of the ranges of voltage mentioned in 63.1.	

39.1.10 With reference to 39.1.9, a heater shall be operated at the maximum rated input. However, for a heater that employs adjustable controls for heater or fan settings, tests at lower heater and fan settings shall also be conducted if the lower settings may produce higher temperatures on heater parts or the test enclosure.

39.1.11 If a heater employs a motor in addition to a heating element, the voltage applied to an integrally connected motor is to be the marked voltage rating of the heater, in accordance with 63.1.

39.1.12 In conducting a test to determine whether or not a heater complies with the temperature requirements, it is to be hung or supported as in service and tested under conditions approximating those of normal operation, except as otherwise noted. Temperatures are to be taken on nearby surfaces, on the supporting surface, at points of support, on attachment plugs, and at other points as may be necessary.

39.1.13 A heater which uses a confined heat transfer fluid shall be fitted with a suitable pressure-measuring instrument, such as a pressure gauge, pressure transducer or similar device, so that the pressure within the heater may be measured during the testing of the heater.

39.1.14 The maximum pressure recorded during the testing of the heater (see 39.1.13) shall serve as a basis for determining the suitability of the strength of the vessel under pressure.

39.2 Temperature controls

39.2.1 The tests are to be performed with any combinations of temperature controls in the circuit and out of the circuit where such combinations may result in higher temperatures or increased risk of electric shock or fire.

Exception: The following controls are to be left in the circuit:

- a) A designated temperature limiting control [see 3.14(b)]
- b) An auxiliary temperature control evaluated as a temperature limiting control with the temperature limiting control out of the circuit.

39.2.2 With respect to 28.1, a tip-over switch that actuates the contacts of a temperature regulating control, shall be rendered inoperative during abnormal tests, including the Tip-Over Test, 41.4.1 – 41.4.4, and during the Element Support Impact Tests, Section 51, and Drop Test, Section 52.

39.3 Specified test conditions

39.3.1 A wall-hung heater is to be supported in the intended manner on the black-painted surface of a wall consisting of 3/8-inch-thick (9.5 mm) plywood fastened to both shorter sides of nominal 2- by 4-inch (38- by 89-mm) vertical wooden studs on 16-inch (406 mm) centers. Two or more such walls are to be fastened together to form a 90-degree angle, and the height and length of the walls are to be such that

they extend not less than 2 feet (610 mm) beyond the physical limits of the heater. The heater is to be located as close to the sides of the wall angle as its construction will permit, and it is to be placed relative to the walls that maximum heating will occur on the latter.

39.3.2 A ceiling-hung heater is to be tested in an alcove consisting of the walls described in 39.3.1, with an added ceiling surface of 3/8-inch (9.5-mm) plywood blanketed on top with 4 inches (100 mm) of conventional glass-fiber or mineral-wool insulation having a minimum R factor of 30 or insulation of lesser thickness having a minimum R factor of 30. The heater is to be mounted on or in the ceiling surface as close to the alcove corner as its physical dimensions will permit unless its design and construction are such that other locations would result in more adverse operation, in which case the heater is to be operated in the more adverse location.

39.3.3 Rubber or other material similarly subject to deterioration is to be removed from feet or other supports of a movable heater if the removal of the material is likely to result in higher temperatures being attained on the heater.

39.3.4 If the removal of feet or other supports results in operation of temperature limiting controls during the Normal Temperature Test, such operation is not considered to be unacceptable if, when the test is repeated with the parts replaced in the intended manner, there is no operation of the controls.

39.3.5 A movable heater is to be supported on two layers of white tissue paper on a softwood surface and placed in a corner alcove as described in 39.3.1. The heater is to be placed as close to the side walls of the alcove as its configuration will permit. If a temperature limiting control operates when the heater is in such position, the test is to be repeated with the heater moved away from the side walls, in one inch increments, until such time that the temperature limiting control does not cycle, or until a maximum of 18 inches (457 mm) is attained.

40 Alarm Device Endurance Test

40.1 With regard to 29.1 and 29.2, an audible alarm device and a control which activates the alarm shall withstand without malfunction or breakdown, an endurance test consisting of 6000 cycles of operation at the rate of 1 minute on and 30 seconds off. The test is to be conducted at rated voltage and at the maximum ambient temperature determined during the Normal Temperature Test, Section 39.

40.2 With regard to 29.1 and 29.3, a visual alarm device and a control which activates the alarm shall withstand without burning out or failing to light, an endurance test consisting of 6000 cycles of operation at the rate of 1 minute on and 30 seconds off. The test is to be conducted at the rated voltage and at the maximum ambient temperature determined during the Normal Temperature Test, Section 39.

41 Abnormal Operation Tests

41.1 General

41.1.1 If the conditions of normal operation are not representative also of abnormal conditions likely to be obtained in actual service, a heater shall not become a risk of fire, electric shock or injury to persons when operated continuously under such abnormal conditions as specified in 41.2 – 41.12 with the temperature controls arranged as described in 39.2.

41.1.2 Unless otherwise specified, abnormal operation tests are to be conducted with the heater operating continuously until the ultimate result has been determined. In most cases, continuous operation for 7 to 8 hours will be necessary in order to prove that the ultimate result has been observed.

41.1.3 If the temperature-limiting control of a wall or ceiling hung heater, cycles at 18 inches (457 mm) from the alcove wall when tested as in 39.3.1 or 39.3.2, all of the abnormal operation tests (overvoltage, stalled fan, padded surface and blanketing, curtain drape, terry cloth drape, and similar tests, usually performed on the heater) are to be repeated while the heater is located in a room having an average temperature of 0°C (32°F).

41.1.4 If the temperature limiting control of a movable heater cycles at 18 inches (457 mm) from the alcove wall when tested as in 39.3.5, all of the abnormal operation tests (overvoltage, stalled fan, tip over, terry cloth drape, terry cloth band drape, vertical wall, and similar tests, usually performed on the heater) are to be repeated while the heater is located in a room having an average temperature of 0°C (32°F).

41.1.5 The applied voltage and method of hanging or location shall be in accordance with Normal Temperature Tests, Section 39. However, for a heater that employs adjustable controls for heater or fan settings, tests at lower heater and fan settings shall also be conducted if the settings influence operation of a temperature limiting control that operates during any abnormal operation test.

41.1.6 When subject to an abnormal operation test, a heater is considered to involve a risk of fire if there is any emission of embers, flame or molten metal, if there is ignition (see 3.9) of the materials described in 41.1.8 – 41.1.13 or if there is glowing or flaming of the combustible material adjacent to or upon which the heater is placed, including, in the case of the vertical wall test, 41.5, charring with crosschecking of the plywood (see 3.3).

41.1.7 After having been subjected to an Abnormal Operation Test, a heater is considered to involve a risk of electric shock or injury to persons if it appears to be usable and the insulation resistance is less than 50,000 ohms, or the heater does not comply with the requirements in Sections 8 or 9.

41.1.8 Insulation resistance is to be measured between current carrying parts and accessible dead metal parts directly or may be calculated using a circuit that measures voltage drop. In such a circuit, the voltmeter shall have an internal resistance of at least 30,000 ohms and a minimum 250-volt direct-current supply circuit shall be used.

41.1.9 The cheesecloth mentioned in this standard is bleached cheesecloth 36 inches wide (914 mm), running 14 – 15 yards per pound mass (approximately 28 – 30 m/kg mass), 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).

41.1.10 The blanket material mentioned in this standard is 100 percent unbleached cotton flannelette sheet blanket, and is generally available in the 80-by-108-inch (2-by-2.7-m) size.

41.1.11 The white duck material (cotton) mentioned in this standard is to have a mass of 8 ounces per square yard (0.27 kg/m²).

41.1.12 The felt mentioned in this standard is 100-percent standard-weight, all-cattle-hair, punched felt with center reinforcement consisting of burlap having a mass of 5 ounces per square yard (0.17 kg/m²). Felt 1 inch (25 mm) thick has a mass of 105 ±15 ounces per square yard (3.56 ±0.51 kg/m²). Felt 3/4 inch (19 mm) thick has a mass of 79 ±9 ounces per square yard (2.68 ±0.31 kg/m²).

41.1.13 The terry cloth material mentioned in this standard is white, basically cotton terry cloth untreated fabric with a polyester content not more than 20 percent, and having a pile weave and a nominal weight of 9.5 ounces per square yard (320 g/m²).

41.2 Overvoltage test

41.2.1 The heater is to be operated at a voltage in accordance with 39.1.12 until constant temperatures are attained, following which it is to be operated for 2 hours at a 12 percent higher voltage.

41.3 Stalled-fan test

41.3.1 A heater that employs a motor-driven air circulating fan shall comply with 41.1, and shall not result in opening a nontime-delay 1/2-ampere fuse, when subjected to the test in accordance with 41.3.2 – 41.3.4.

41.3.2 A heater is to be positioned or located in accordance with the Normal Temperature Tests, Section 39. A 1/2-ampere fuse of other than the time-delay type is to be connected between the accessible dead metal parts (see 51.10) of the heater and the earth ground. The grounded conductor and a grounding conductor, if provided, are to be treated as described in 51.3.

41.3.3 The motor is to be stalled and the heater is to be operated for 7 hours unless a manual reset type temperature limiting control or a thermal cut-off operates to de-energize either all or a sufficient number of heating elements so that there is no longer a risk of fire or development of an electric shock.

41.3.4 For a heater that employs adjustable heat setting controls, this test shall also be conducted at other than maximum rated input if the other settings influence operation of an auxiliary temperature control or a temperature limiting control.

41.4 Tip-over test

41.4.1 A movable heater shall be subjected to this test. The heater is to be operated until constant temperatures are attained. It shall be then overturned onto a softwood surface covered with a single layer of terry cloth and shall be operated under the most severe conditions that would result when it comes to rest, without further guiding or propping, after having been pushed over.

41.4.2 All orientations are to be tested. However, if a given orientation or position of the heater presents less likelihood of a risk of fire than when the heater is evaluated in accordance with other requirements in the standard, the orientation or position need not be reevaluated under 41.4.1.

41.4.3 For a heater which contains a confined heat transfer fluid, and is intended to be shipped with the legs or base detached, the test is to be conducted with the legs or base installed as well as detached.

41.4.4 If a heater incorporates a tipover switch of other than the type indicated in 39.2.2, it shall be evaluated according to 32.18 for each orientation or position of the heater in which the switch is relied upon to prevent a risk of fire.

41.5 Vertical-wall test

41.5.1 A movable heater shall be operated at a distance from the wall that results in the highest temperature on the wall. The highest temperatures are usually encountered at the closest distance a heater can be placed to the wall, except that:

- a) A temperature limiting control or an auxiliary temperature control may operate and not permit operation of the heater for sufficient length of time to produce the highest temperatures. In this case additional tests are to be conducted at increased distances between the heater and the wall. The test time at each distance is to be sufficient to observe the ultimate results. See 41.5.2.

b) If a radiant type heater is provided with a reflector, the reflector may have a focusing effect that causes higher temperatures at a greater distance than the minimum distance between the heater and the wall. In this case additional tests are to be conducted at increased distances. The test time at each distance is to be sufficient to observe the ultimate results. See 41.5.2.

41.5.2 With respect to 41.5.1, to observe the ultimate results, the test is to be continued for 7 hours. However, the test may be discontinued after 2 hours if this duration of testing produces no discoloration of the terry cloth material.

41.5.3 The heater is to be supported on a horizontal surface that abuts the vertical wall. The side of the heater that radiates or convects heat is to face the wall. The wall is to consist of 3/4-inch (19.1-mm) thick fir plywood, and is to be covered with one layer of terry cloth material. The wall is to be constructed so the grain of the plywood runs in the horizontal direction. The wall is to extend at least 12 inches (305 mm) beyond the heater on both sides and 12 inches above the heater. Any heater projections such as guards or grilles in the front of the heater that do not require tools for their removal (see 10.1.1) are to be removed.

41.5.4 For a heater that includes a stand or feet that project beyond other heater surfaces in front of the heater, the wall is to include a recessed "toe space" next to the floor. The "toe space" shall be 3-1/4 inches (82.6 mm) deep, 4-1/4 inches (107.9 mm) high which, with respect to the heater feet or stand, determines the closest distance the heater can be placed to the wall. The terry cloth material is to be applied to the vertical wall such that it extends to the floor, draping over the "toe space" opening. When the heater is inserted, the terry cloth will contour the stand or feet of the heater.

Exception: For a heater that may be used at an elevated location (see 3.6) and that includes a stand or feet that project beyond other heater surfaces in front of the heater and that is provided with air outlet openings lower than 4-1/4 inches from the floor, the height of the "toe space" is to be adjusted to a minimum height permitted by the stand or feet.

41.5.5 For a heater that is not provided with a stand or feet that project beyond other heater surfaces in front of the heater, the wall is to extend straight to the floor without a "toe space" and the heater is to be placed flush against the wall.

Exception: A heater that may be used at an elevated location that includes a stand or feet that extend beyond the front of the heater shall be tested using a wall that includes a "toe space" as described in 41.5.4 and also using a wall without a "toe space".

41.6 Terry cloth drape test

41.6.1 A heater of other than the ceiling-hung type is to be operated until constant temperatures are attained and then covered with a single layer of terry cloth. The test is to be repeated (if acceptable results are obtained for the initial condition) beginning with the heater at room temperature ($25 \pm 3^{\circ}\text{C}$). The tests under the two conditions may be combined by initially draping the heater, and after equilibrium conditions are obtained, replacing the terry cloth with a new single layer.

Exception: The temperature-regulating control may be returned to the circuit during the test starting from room temperature if the heater does not employ an automatic reset type temperature-limiting control.

41.6.2 A heater provided with an auxiliary temperature control or a temperature limiting control that does not cycle due to partial draping of the heater shall also be subject to the Terry Cloth Drape Test under such partial draping conditions.

41.6.3 A heater designed to be supported by and mounted away from a wall or ceiling in a horizontal position is to be tested in the intended position with a single layer of terry cloth draped over the full length of the heater and hanging down approximately 1 foot (305 mm) on each side.

41.6.4 In a test to determine whether a combination heater and motor-driven fan complies with the requirement in 41.6.1, the fan is to be operating when the heater is covered with terry cloth. If the motor is separately controlled, the test is to be repeated with the fan motor in the off position.

41.6.5 The lower edge, or edges, of the terry cloth shall hang freely without any added constraint so that the heated air discharge may cause the terry cloth to billow away from the heater. If necessary, the uppermost portion of the terry cloth is to be taped or otherwise secured to the top of the heater or the wall above the heater to prevent the terry cloth from being blown off the heater.

41.7 Terry cloth band drape test

41.7.1 A movable heater that is designated for use at an elevated location or because of its size and weight is likely to be used at an elevated location (see 3.6) shall be subjected to the Terry Cloth Band Drape Test before and also after it is subjected to the Drop Test, Section 52, provided it is operational after the drop test.

41.7.2 The terry cloth material is to be in accordance with 41.1.13. The terry cloth material is to be folded to form a six-layer band, 6 inches (152 mm) wide. Except as stated in 41.7.8, the layered band is to be of sufficient length to extend vertically over two opposite sides and the top of the heater and include allowance for offset folds and at least a 3 inch (76.2 mm) overlap on the floor at both ends when the band is applied in accordance with 41.7.4 and 41.7.7 – 41.7.9. If the band slides off the heater due to the force of gravity, it is to be supported to maintain its position for test purposes. The support shall not restrict the heater airflow. After the initial positioning the band shall not be repositioned if it is deflected by the heated air discharge.

41.7.3 With respect to the draping in accordance with 41.7.4 and 41.7.7 – 41.7.9, the width of the heater is considered that portion of the heater through which heated air is delivered or heat is radiated.

41.7.4 The terry cloth band is to be applied so that it contours the heater over two vertical or near vertical sections of the heater and extends across the top of the heater. One of the vertical sections is to extend over the front of the heater to cover the opening or openings through which heated air is delivered or heat is radiated. The other vertical section is to be applied so that it covers one of the following sections of the heater. Depending on the construction of the heater, all of these applications are to be tested, one at a time, unless it can be determined without testing which of the applications will produce the most adverse effects, in which case the most adverse applications only need to be tested.

- a) The section in the back of the heater directly opposite the front section covered by the band.
- b) A section of the heater which includes air intake openings that may be either on the back of the heater not directly opposite the band section in the front of the heater, or on the side of the heater. Any offsets required in the band, except as indicated in 41.7.8, are to be made by a single fold on top of the heater.

41.7.5 The heater is to be operated initially at least 15 minutes at maximum rated wattage in accordance with the Power Input Test, Section 37. The heater is then to be draped with the terry cloth band in accordance with 41.7.4 and 41.7.7 – 41.7.9 and operated continuously for 7 hours or until:

- a) One half hour after a manual reset type temperature limit control or a thermal cut-off operates to de-energize either all or a sufficient number of heating elements so that there is no longer a risk of fire or development of an electric shock; or
- b) Thermal stabilization occurs and there is no discoloration of the terry cloth material.

41.7.6 If the heater includes adjustable settings for heat output, other than maximum setting, these other settings are also to be tested, unless it can be determined without testing that the maximum setting will produce the most adverse conditions.

41.7.7 With respect to 41.7.5, at least the following test conditions are to be included with the terry cloth band draped over the heater. See 41.7.2.

- a) The band placed to cover the center of the width of the heater and extended to cover the top of the heater and the corresponding part of the opposite side.
- b) The band placed to cover one half of the width of the heater and extended to cover the top and the corresponding part of the opposite side. For a heater that is more than 12 inches (305 mm) wide so that the 6 inch (152 mm) wide band does not cover one half of the width of the heater, the band is to be placed so that one edge is even with the vertical center line of the width.
- c) The band placed to cover one fourth of the width of the heater and extended to cover the top and the corresponding part of the opposite side of the heater. For a heater that is more than 24 inches (609 mm) wide so that the 6 inch wide band does not cover one fourth of the width of the heater, the band is to be placed so that one edge is even with one edge of the width.
- d) The tests specified in (b) and (c) are to be repeated with the other half of the heater covered.
- e) If the width of the heater is more than 24 inches (61 cm) wide so that placement of the terry cloth band in accordance with (b), (c), and (d) will not cover tests on all sections of the width, additional tests are to be conducted with the band placed so that it is centered on the part of the width of the heater not covered by (b), (c), and (d).
- f) If a heater includes air intake openings on other sections of the heater that are not included in the width of the heater (see 41.7.3), the test described in (c) and the corresponding test on the other half of the width of the heater are to be repeated with the band extended to cover the top and the section of the heater with these air intake openings, as specified in 41.7.4(b).

41.7.8 With reference to 41.7.7, if it is discovered during the testing that a location of the band different than specified in (a – f) may produce more adverse effects due to placement of temperature limiting controls or projecting heater surfaces, the placement of the band is to be modified to cover the more adverse conditions. In heater constructions where the intake openings are in the front section of the heater or to the side of the heater outlet opening or where the intake openings are in the front section of the heater and to the side of the heater outlet opening, this may necessitate a double fold in the terry cloth material. However, except for the folds on the top of the heater, the band placement is to be vertical or near vertical with respect to the heater, contouring the heater enclosure and its projections, if any. The bottom edge of the terry cloth band shall be raised to any position above the supporting surface if doing so produces a more adverse effect than when the edge is touching or laying on the supporting surface.

41.7.9 If a heater is provided with vertical guards or grille members in the front of the heater that do not permit placement of the entire width of the 6 inch (152 mm) wide band in parallel with the heater surfaces, tests are to be conducted so that portions of the bands penetrate between the vertical guards as far as permitted by the guards or other parts of the heater.

41.7.10 For all drapings specified in 41.7.7 – 41.7.9, the terry cloth is to be allowed to fall naturally over the heater and not forced. However, for testing a heater provided with vertical guards or grille members, the terry cloth can be turned sideways to penetrate between the guards or grille members more easily.

41.8 Wall-hung heaters

41.8.1 General

41.8.1.1 Unless marked in accordance with 64.12 or 64.14, a wall-hung heater, shall be tested in accordance with 41.8.2.1 – 41.8.3.1.

41.8.2 Padded surface and blanketing

41.8.2.1 A wood surface covered with a 1 inch (25 mm) thick felt pad, and with the pad, in turn, covered by a double layer of cheesecloth, is to be supported in a vertical position as near the heater as the construction of the latter will permit. The heater is to be covered to such an extent as to produce maximum heating of the cheesecloth, and the padded surface is to extend at least 3 inches (76 mm) above the top surface of the heater. During the test, the covered wood surface is to be moved horizontally 1/2 inch (13 mm) away from its initial position and operation continued until temperatures stabilize. If it is determined that its temperature increases when the surface is moved horizontally, the test is to be repeated with the surface in the new position starting with the heater at approximately room ambient temperature. The wood surface is to be of sufficiently rigid construction so that it will not change shape (bow or warp) during the test.

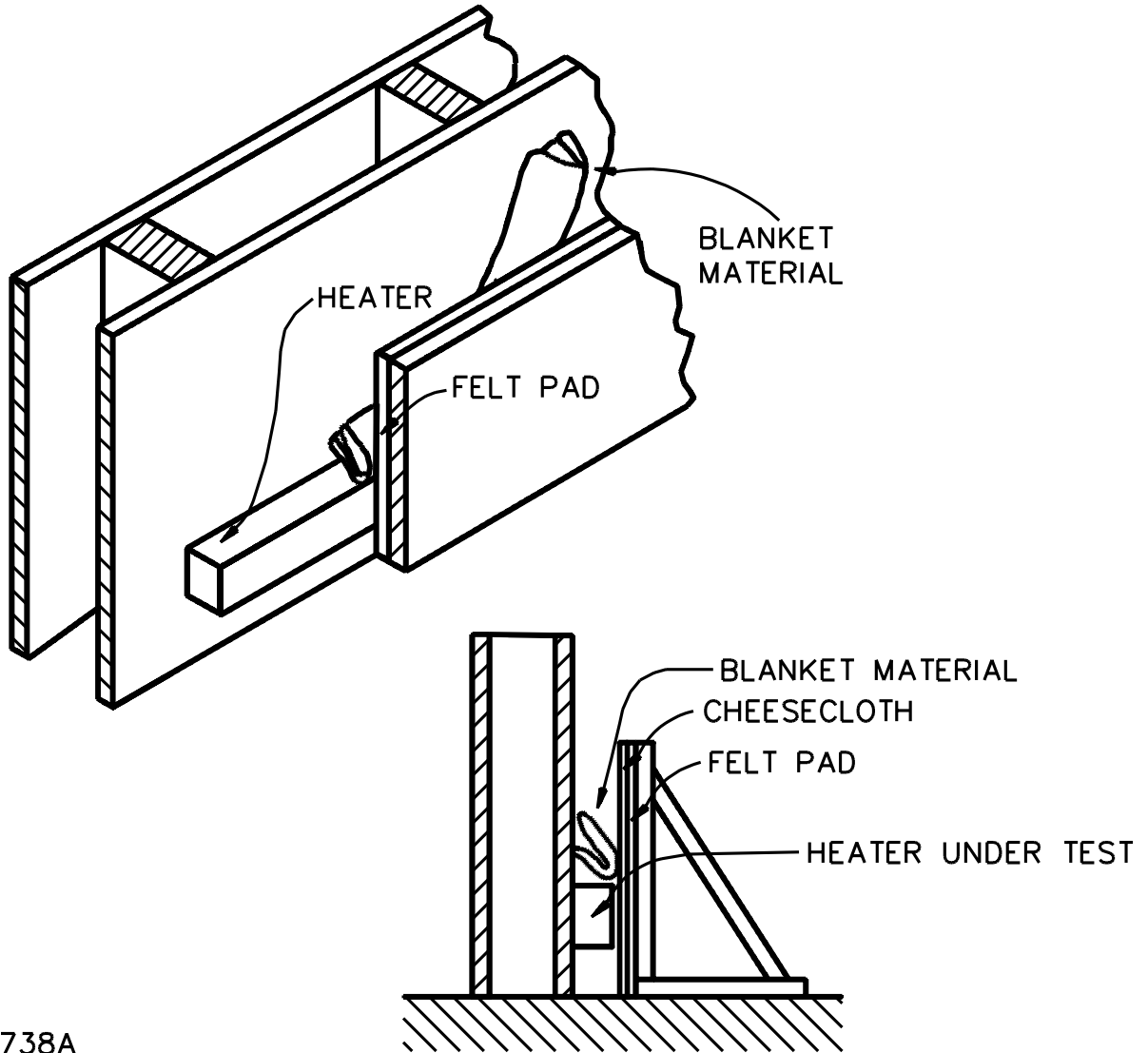
41.8.2.2 While still operating as described in 41.8.2.1 with the padded vertical surface in its initial position in front of the heater, four thicknesses of loosely folded cotton blanket material are to be introduced into the space between the vertical padded surface and the vertical wall on which the heater is hung in such a manner that the upper slot of the heater is blocked. The folded blanket material is to be located at any points along the length of the heater installation in such a manner that any sensing device provided is so exposed as to produce the most adverse operating conditions. A length of folded material up to a maximum of 80 inches (2 m) is to be used, but a shorter length of the material may be introduced into the space at any one time to obtain the most adverse operating conditions possible. Operation in any one blocked condition is to be continued until constant temperatures are obtained, or until glowing or flaming of the cotton blanket material results. A typical test setup is shown in Figure 41.1.

41.8.3 Curtain drape

41.8.3.1 The upper edge of a simulated curtain at least 3 feet (0.9 m) high, but long enough to be supported at least 1 foot (300 mm) above the heater in any case, is to be continuously attached to the wall at the base of which the heater is installed. The curtain is to consist of white duck as specified in 41.1.11 and an overlay of a double layer of cheesecloth on the side facing the heater, and is to be hung so that the lower edge just touches the floor. During the test, the entire length of the heater is to be initially covered and the curtain is to be arranged to conform as closely as possible with the contour of the heater. Those sections judged to be least likely to affect the operation of the temperature limiting control are to be covered. This test shall then be repeated with first:

- a) 3/4 of the heater covered, then with

Figure 41.1
Test of wall-hung heater



S2738A

- b) 1/2 of the heater covered, and then with
- c) 1/4 of the heater covered.

Each test shall be conducted with the heater at room ambient at the start of the test.

41.9 Abnormal ambient test

41.9.1 General

41.9.1.1 A heater that employs an automatic reset auxiliary temperature control or a temperature limiting control in accordance with (a) of exception to 28.1 shall be subjected to an abnormal ambient test in accordance with either Condition 1 or Condition 2 as specified in 41.9.2 and 41.9.3, respectively. The test is to be continued for 7 hours with the heater operated at the maximum rated input. Subsequent to this test, the heater shall comply with the Normal Temperature Tests, Section 39.

Exception No. 1: The abnormal ambient test need not be conducted for a heater in which the average "on" time per cycle over four cycles of operation on the auxiliary temperature control or the temperature limiting control, whichever results in actuation of an alarm, during each abnormal operation temperature test does not exceed 5 percent and the average "on" time does not exceed 1 minute.

Exception No. 2: The abnormal ambient test need not be conducted if:

- a) The heater completes the full 7 hour terry cloth band drape test,*
- b) During the full terry cloth band drape test temperatures are measured as noted in the Normal Temperature Tests, Section 39, and*
- c) The temperatures measured during the normal temperature test are equal to or greater than the temperatures obtained during the terry cloth band drape test with the product operating on the auxiliary temperature control or the limiting control, whichever results in actuation of an alarm.*

Exception No. 3: The abnormal ambient test need not be conducted if the heater:

- a) Complies with the locked rotor test (see 41.3.1 – 41.3.4) and temperatures are measured as noted in the Normal Temperature Tests, Section 39, and*
- b) If the steady state temperatures measured during the normal temperature test are equal to or greater than the temperatures obtained during the locked rotor test with the product operating on the auxiliary temperature control or temperature limiting control, whichever results in actuation of an alarm. The overshoot temperatures are not to be considered if they last for less than 5 minutes.*

Exception No. 4: A heater employing an automatically reset auxiliary temperature control need not be provided with an alarm if the heater complies with 39.1.1 (normal temperature tests) when operated with the auxiliary temperature control operational and with the temperature limiting control bypassed under the abnormal operation conditions specified in 41.2 – 41.12.

41.9.2 Abnormal ambient test – condition 1

41.9.2.1 The heater is to be placed in an enclosure where the ambient can be elevated and accurately maintained while the heater is operating. The ambient is to be raised slowly until the auxiliary temperature control or the temperature limiting control operates. The control is then to be shunted out of the circuit and the heater is to be operated at the ambient at which the control operated, plus or minus 10°F (5.6°C) for 7 hours.

41.9.3 Abnormal ambient test – condition 2

41.9.3.1 Air heated by a controlled temperature source is to be directed to the air intake openings of the heater using air ducts or other similar means. The temperature of the air is to be gradually increased until the auxiliary temperature control or the temperature limiting control operates. The control is then to be shunted out of the circuit and the heater is to be operated for 7 hours with the intake air maintained at the temperature at which the control operated, plus or minus 10°F (5.6°C).

41.10 Motor overload and stalled motor – motors protected by a remote protective device

41.10.1 A motor protected by a remote protective device in accordance with 25.1(b) shall not burn out nor shall there be other evidence of risk of fire when tested in accordance with 41.10.2 – 41.10.6.

41.10.2 The motor and its protective device are to be connected in the intended manner to a supply circuit having a voltage in accordance with 39.1.9. Temperatures are to be measured by thermocouples secured to the surface of the motor coils.

41.10.3 The motor and its protective device are to be tested in the ambient encountered in the operation of the heater in which the motor and its protective device are employed as determined during the applicable normal temperature test.

Exception No. 1: A motor that encounters an ambient higher than normal room ambient, 25 – 26°C (77 – 79°F), during the applicable normal temperature test may be tested in a lower ambient. However, the maximum allowable temperatures specified in 41.10.4 and 41.10.5 are to be reduced by the difference between the ambient encountered in intended operation and the test ambient.

Exception No. 2: An ambient compensated protective device may be tested in any ambient from 25 – 50°C (77 – 122°F).

41.10.4 When a motor is operating under the maximum load that it can carry without causing the protective device to function, the winding temperature shall not exceed 140°C (284°F) for a Class A insulated motor or 165°C (329°F) for a Class B insulated motor.

Exception: A motor moving air only by means of a fan or blower directly attached to the motor shaft need not comply with this requirement.

41.10.5 When the rotor of a motor is locked, the winding temperature for a Class A insulated motor shall not exceed 200°C (392°F) during the first hour of operation and 175°C (347°F) thereafter. After the first hour of operation, the average temperature (that is, the average of (1) the arithmetic mean of the maximum temperatures and (2) the arithmetic mean of the minimum temperatures) shall not exceed 150°C (302°F). For a Class B insulated motor, the corresponding temperatures shall not exceed 225°C (437°F) for the first hour, 200°C after the first hour, and 175°C for the average temperature.

Exception: A motor employing a thermal cutoff as a remote protective device need not comply with this requirement.

41.10.6 The locked rotor test on a manually reset device is to be continued for four operations of the protective device, with the device being reset as quickly as possible after it is opened. For an automatically reset device, the locked rotor test is to be continued for 72 hours unless the equipment includes other controls – such as a timer– that will demonstrably limit the duration of the operation to a shorter interval.

41.11 Impedance-protected motors

41.11.1 An impedance-protected motor shall comply with the applicable requirements in the overheating protection for motors, UL 2111, under the conditions to which the motor is exposed in the heater, with the rotor locked. Compliance with this requirement is to be determined in accordance with:

- a) 41.11.2 for wall-hung and ceiling-hung heaters that are intended to be operated in a specific fixed position, and
- b) 41.11.2 for movable heaters.

See 41.11.4.

Exception: If a temperature limiting control, including a thermal cutoff, in the heater operates when the rotor is locked, the applicable temperature limits in the Standard for Overheating Protection for Motors, UL 2111 may be applied. Such temperature limiting controls and thermal cutoffs shall comply with the requirements in UL 2111 concerning the number of such devices to be tested and the test time.

41.11.2 A wall-hung or ceiling hung heater, intended to be operated in a specific fixed position, is to be installed and operated in accordance with Normal Temperature Tests, Section 39, with the rotor of the motor locked.

41.11.3 A movable heater is to be arranged as specified in the Normal Temperature Tests, Section 39. The heater and the motor are to be energized in accordance with 39.1.9 and 39.1.11. The heater is to be operated with the rotor of the motor locked with the heater located in a test alcove described in 39.3.1 under the conditions described in 39.3.5.

41.11.4 If a motor has been previously tested in accordance with the Standard for Overheating Protection for Motors, UL 2111, this testing can be discontinued if the winding temperature is no higher than the previous test results.

41.12 Motor connected across heating elements

41.12.1 A heater provided with a motor connected across a portion of a resistance element shall be subject to the applicable tests of 41.12.2 – 41.12.5.

41.12.2 Compliance with 41.12.1 is to be determined by testing three representative heaters. The heaters are to be tested in accordance with the conditions specified in Normal Temperature Tests, Section 39 or as described in 41.12.5. The heating element connected in parallel with the motor is to be open-circuited (see 41.12.4) and two layers of cheesecloth are to be draped to cover all air inlet and outlet openings of the heater. The heater is to be operated continuously until either motor burnout or stabilized motor temperature occurs.

41.12.3 With respect to 41.12.2, any of the results listed (a) – (c) are considered to comply with 41.12.1:

- a) Motor burnout within 1 hour without emission of flaming particles, molten metal, or ignition or glowing of the cheesecloth.

b) If the thermal protector of a thermally protected motor operates, the operation is to be continued for 15 days in accordance with the Standard for Overheating Protection for Motors, UL 2111. The temperature limits for locked rotor conditions specified in UL 2111 shall not be exceeded. It is acceptable for the protector to permanently open-circuit during the test.

c) If no burnout or no operation of a thermal protector occurs, the operation is to be continued until the temperatures stabilize. The temperature rise of the motor winding shall not exceed the rise specified in Table 39.1 for the motor coil.

Exception: If the temperature rise of the motor exceeds the rise specified in Table 39.1, the operation is to be continued for 15 days and temperatures are to be monitored. The measured temperatures shall not exceed the temperature limits for locked rotor conditions specified in the Standard for Overheating Protection for Motors, UL 2111.

41.12.4 For a heater that includes more than one heating element in parallel with the motor, the test described in 41.12.2 is to be conducted by first opening one of the elements. If the opening of one element does not manifest itself in the heater operation, the temperature of the motor windings shall not exceed the limits specified in Table 39.1 and the test shall be repeated with other elements in parallel with the motor opened.

41.12.5 At the manufacturer's option, certain motor or motor and thermal protector combinations as described in (a) and (b) can be tested as specified in 41.12.2 and 41.12.3 except independent of the heater. The test voltage is to be that to which they will be subjected if the parallel-connected heating element opens. During the test, two layers of cheesecloth are to be draped over the motor and there shall be no ignition of the cheesecloth and no emission of molten or flaming particles, and the temperature of the motor shall comply with 41.12.3.

a) A motor and the thermal protector combination if the thermal protector operates at the increased voltage and it is not ambient compensated.

b) An impedance-protected motor that is expected to burn open within 1 hour.

42 Endurance Test

42.1 Temperature Control

42.1.1 An automatic control and an automatic-control assembly (that is, a temperature control and related contactor) shall withstand an endurance test consisting of the number of cycles indicated in Table 42.1. Unless it is specified that the test be made without load, the current-rupturing device shall make and break at least the rated current of the heater while connected to a circuit of at least the voltage specified in 39.1.9. There shall be no electrical or mechanical malfunction of the automatic control or associated contactor or undue burning, pitting, or welding of contacts.

42.2 Electrical wiring

Added SubSection 42.2 effective December 21, 2000

42.2.1 An air heater in which a normal function causes movement of the power supply cord, electrical wiring or other insulated live parts, such as a base which adjusts the air heater to direct heated air to a desired position, shall withstand an endurance test for the number of cycles described in 42.2.2. Upon completion of the test:

a) There shall be no electrical or mechanical malfunction of the air heater,

- b) There shall be no exposure of an uninsulated conductor strand either within or outside of the enclosure, and
- c) The air heater shall comply with the Dielectric Voltage-Withstand Test, Section 47.

42.2.2 The endurance test required by 42.2.1 is to consist of:

- a) 100,000 cycles of operation for an air heater in which the movement of the power-supply cord, electrical wiring or other insulated live parts occurs as a result of the operation of an automatic mechanical feature, such as a motorized base not prohibited from being separately activated; or
- b) 6000 cycles of operation for an air heater in which the movement of the power-supply cord, electrical wiring or other insulated live parts occurs only as a result of the operation of a manual feature, such as a swivel base that requires a user to manipulate the air heater.

42.2.3 Where movement of electrical wiring or other insulated live parts occurs, six representative air heaters shall be subject to this test. Throughout the test the air heater shall be continuously energized at maximum rated input in accordance with 39.1.9 by short-circuiting any and all temperature controls. The movable member shall be operated so that it will reach the limits of travel in both directions during each cycle by either the automatic mechanical feature of the heater or by a separate mechanical arrangement that operates the movable member. The cycling rate shall be approximately one of the following:

- a) Twelve cycles per minute.
- b) At the rate at which the automatic mechanical feature in the air heater operates, if the rate is less than 12 cycles per minute, or
- c) Greater than 12 cycles per minute using the mechanical arrangement, if agreeable to all concerned, or as controlled by the automatic mechanical feature.

42.2.4 The endurance test described in 42.2.2 shall be conducted on six representative power-supply cords assembled to heaters, simulated mounting surfaces, or test fixtures so as to not interfere with the test procedure. Each assembly is to be mounted so that rotation is centered through the normal operating position of the air heater. For the start of the test, the axis of the power supply cord is to be positioned vertically with the attachment plug end down. The cord is to be passed through a fixed horizontal plane, having a smoothly rounded, 1-inch (25-mm) diameter opening, located 2 feet (610 mm) below the power supply cord entry into the air heater. The free end of the cord is to be attached to a 1/4-pound (110-gram) unsupported weight. One or more complete air heaters of the maximum rating intended for use with the power supply cord and with any and all temperature controls short-circuited, or the leads of each assembly that are normally connected to the air heater are to be connected to a load that draws the same current. The six assemblies are to be flexed through an angle of approximately 180 degrees for each cycle. A cycle consists of 90-degree rotation of the test assembly in one direction, 180-degree rotation in the opposite direction and then return to the starting point.

Table 42.1
Number of cycles of operation for endurance test

Type of temperature control	Automatic reset	Manual reset
Temperature-regulating and auxiliary	A number of cycles equivalent to 1000 hours of intended operation of the heater, but not less than 6000 if a household heater, or 30,000 if a commercial heater.	To be made the subject of special consideration. No value is specified because of unlikely occurrence
Temperature-limiting	A number of cycles equivalent to 100 hours of operation of the heater under any condition which causes the control to function, or 100,000 cycles, whichever is greater.	1000 cycles under load and 5000 cycles without load

43 Short Circuit Tests

43.1 Devices and conductors referenced in 26.1.2(c) and Exception No. 3 to 26.4.3 shall withstand short circuit and ground fault conditions when protected by:

- a) A device that is acceptable for branch circuit protection and is located in the heater, or
- b) A branch circuit overcurrent protective device of the type and maximum rating specified on the heater nameplate.

There shall be no damage to the conductor or its termination, no ignition of the cheesecloth surrounding the enclosure housing the components under test, and no arc-over between line- and low-voltage circuits.

43.2 For the purpose of these tests:

- a) Circuit breakers and fuses are not considered to be interchangeable,
- b) Fuses of the same rating are considered to be interchangeable,
- c) HACR type circuit breakers of the same rating are considered to be interchangeable, and
- d) Circuit breakers of other than the HACR type are not considered to be interchangeable with each other or with HACR type circuit breakers.

43.3 Each device and each conductor is to be connected in a circuit having a minimum capacity based on the maximum rated current and voltage of the heater in accordance with Table 43.1. Each concurrent load condition is to be considered separately, and the maximum resulting current employed as the basis of selection of the capacity of the test circuit. The voltage source for the test circuit is to be an alternating voltage and the circuit capacity is to be measured without the devices or the conductors in the circuit.

Table 43.1
Short-circuit test currents

Product ratings, amperes				Current capacity amperes
Single Phase				
110 – 120 V	200 – 208 V	220 – 240 V	254 – 277 V	
9.8 or less	5.4 or less	4.9 or less	–	200
9.9 – 16.0	5.5 – 8.8	5.0 – 8.8	6.65 or less	1000
16.1 – 34.0	8.9 – 18.6	8.1 – 17.0	–	2000
34.1 – 80.0	18.7 – 44.0	17.1 – 40.0	–	3500
Over 80	Over 44	Over 40.0	Over 6.65	5000

3 Phase				Circuit capacity amperes
200 – 208 V	220 – 240 V	440 – 480 V	550 – 600 V	
2.12 or less	2.0 or less	–	–	200
2.13 – 3.7	2.1 – 3.5	1.8 or less	1.4 or less	1000
3.8 – 9.5	3.6 – 9.0	–	–	2000
9.6 – 23.3	9.1 – 22.0	–	–	3500
Over 23.3	Over 22.0	Over 1.8	Over 1.4	5000

43.4 Each of three representative specimens of each conductor is to be subjected to each test condition. A new protective device is to be used for each test condition. Consideration is to be given to both short-circuit and ground-fault conditions.

44 Overload Test – High-Voltage Transformers

44.1 This test applies to a high-voltage transformer provided with thermal protection of other than the nonrenewable thermal cutoff type. See 26.5.2.

44.2 Temperatures measured on the surface of the windings of a thermally protected high-voltage transformer shall not exceed the temperature indicated in 44.4 when the transformer is tested as indicated in 44.3 and 44.4.

44.3 A variable resistance load is to be connected to the output terminals and the transformer is to be operated continuously at the test voltage indicated in 39.1.9. If the protective device controls a switching device that, in turn, interrupts primary current to the transformer, the switching device is to be included in the circuit. The test ambient temperature is to be approximately 25°C (77°F). The resistance load is to be adjusted so that the transformer winding is brought to a stabilized temperature of approximately 10°C (18°F) below its insulation rating. The load is then to be gradually increased until operation of the protector occurs.

44.4 Each of three of the transformer-protective device combination is to be tested. Average temperatures of the three representative devices shall not exceed the winding insulation rating and the temperature of any one representative device shall not exceed the insulation rating by more than 5°C (9°F).

44.5 Upon completion of this test, each representative device shall comply with the Dielectric Voltage-Withstand Test, Section 47.

45 Burnout Test – High-Voltage Transformers

45.1 There shall be no emission of flame or molten metal from the heater enclosure when a high-voltage transformer is operated under the conditions described in 45.2 and 45.3.

Exception: This test does not apply to a high-voltage transformer that is provided with thermal overload protection of other than the nonrenewable thermal cutoff type (see 26.5.2) or that is protected by an overcurrent device or devices complying with the requirements in 26.5.4 – 26.5.8.

45.2 Three transformers shall be operated continuously at the normal test voltage indicated in Table 39.2 and at rated frequency with the enclosure grounded. The test ambient temperature is to be approximately 25°C (77°F) and operation is to be continued until constant temperature is indicated by a thermocouple on the enclosure or until burnout occurs. The circuit on which the transformer is tested is to be protected by fuses rated not less than that required for the heater.

45.3 The load connected to the output terminals is to be the highest of the following and is to be readjusted to the specified value after 2 minutes of operation if necessary, with no further readjustment during the test.

- a) A resistance load to provide a current equal to three times the full rated transformer secondary current, or
- b) If the transformer supplies a motor with or without additional loads, a resistance load to provide a current equal to the motor locked rotor current plus any additional loads, or
- c) If the transformer supplies an inductive load (other than a motor), such as the coils of relays, solenoids, and the like, a resistance load to provide a current equal to the sum of such loads with the armature of the largest blocked open.

Exception: The test may be conducted with the output terminals short circuited if this results in less than three times rated secondary current.

46 Component Failure Test

46.1 If a heater employs one or more rectifiers, transistors, or similar solid-state components, no risk of fire or electric shock shall develop when the circuit between any two terminals of any such component is open-circuited or short-circuited. If the heater employs a capacitor in combination with one or more of the above-mentioned components, no risk of fire or electric shock shall develop when the capacitor is short-circuited. Only one of the simulated fault conditions described above is to be imposed at one time. See 46.2 – 46.5.

Exception: Components located on the secondary of a Class 2 transformer need not comply with these requirements.

46.2 If a semiconductor rectifier is employed, three representative devices shall be tested with the rectifier terminals connected together. Three additional devices shall be tested with the terminals of the electrolytic capacitor connected together.

46.3 Three complete tests are to be made under each of the conditions described in 46.2 using new components in each test. The equipment to be tested is to be operated as indicated in 41.1.2.

46.4 An unacceptable condition is considered to exist if flame is emitted from the overall enclosure of the equipment or if a permanently conductive path is established between live parts and exposed dead metal.

46.5 The tests described in 46.1 – 46.3 may be omitted if one or both of the following conditions exist:

- a) There is 10,000 ohms or more of additional series impedance in a circuit in which the voltage is 125 or less.
- b) There is 20,000 ohms or more of additional series impedance in a circuit in which the voltage is more than 125 but is no more than 250.

47 Dielectric Voltage-Withstand Test

47.1 A heater shall withstand for 1 minute without breakdown the application of a 60-hertz essentially sinusoidal potential between live parts and noncurrent-carrying metal parts, with the heater at its maximum normal operating temperature. The test potential (rms) shall be 1000 volts for a heater rated at 250 volts or less and 1000 volts plus twice rated voltage for a heater rated at more than 250 volts.

47.2 To determine whether or not a heater complies with the requirement in 47.1, it is to be tested by means of a 500-volt-ampere or larger capacity transformer, the output voltage of which can be regulated and is essentially sinusoidal. The increase in the applied potential is to be at a uniform rate and as rapidly as consistent with its value being correctly indicated by a voltmeter.

48 Insulation Resistance Test

48.1 A heater employing thermal insulation such as mineral wool in contact with uninsulated live parts or electrical insulating material that is likely to be affected adversely by moisture under the conditions of intended use shall have an insulation resistance of not less than 50,000 ohms when tested as specified in 41.1.8 after exposure for 24 hours to moist air having a relative humidity of 85 \pm 5 percent at a temperature of 34.0 \pm 2.0°C (89.6 \pm 3.6°F). See 18.2.

49 Water Spray Test

49.1 When tested as described in 49.2 – 49.4, a heater intended for outdoor use shall:

- a) Have an insulation resistance of not less than 50,000 ohms between live parts and interconnected noncurrent-carrying metal parts;
- b) Withstand without breakdown for 1 minute the application of a 60-hertz essentially sinusoidal potential between live parts and interconnected noncurrent-carrying metal parts. The test potential (rms) shall be 1000 volts if the heater is rated 250 volts or less, and shall be 1000 volts plus twice rated voltage if it is rated more than 250 volts; and

49.2 During the test, the heater is to be mounted or supported as it would be in actual service. If a heater is provided with a shelter, shield, or similar device (see 64.18), is to be mounted therein. A radiant reflector-type heater is to be suspended in any intended operating position.

49.3 The heater is to be subjected for 4 hours to a water spray as described in 49.4 applied at an angle of 45 degrees from the vertical. The insulation-resistance and dielectric voltage-withstand tests are to be conducted immediately upon conclusion of exposure to the water spray.

49.4 The water-spray-test apparatus is to consist of three spray heads mounted in a water supply pipe rack as illustrated in Figure 49.1. Spray heads are to be constructed in accordance with the details illustrated in Figure 49.2. The heater is to be positioned in focal area of the spray heads so that the greatest quantity of water is likely to enter the heater. The water pressure is to be maintained at 5 pounds per square inch (34.5 kPa) at each spray head.

50 Stability of Movable Heaters

50.1 A movable heater shall return to its intended at-rest position on a level surface after being tipped in any direction to an angle of 10 degrees from horizontal.

50.2 The test is to be conducted on the unit when placed under the most unfavorable conditions. The heater is to be arranged with all doors and other appurtenances in the position tending to decrease stability. The legs or other points of support may be blocked to prevent the unit from sliding.

51 Element Support Impact Tests

51.1 A movable heater shall neither:

- a) Emit sparks, flames, or molten metal, nor
- b) Cause the terry cloth to ignite, nor
- c) Open a 1/2 ampere fuse of other than the time-delay type installed in accordance with 51.2, when tested as described in 51.5 – 51.7.

Exception: A heater need not be tested if it employs either rigid heating elements, such as resistive elements encased in rigid dead metal tubing, or heating elements that can be determined without test not to involve a risk of fire or electric shock when broken, such as heating lamps.

51.2 The 1/2-ampere fuse is to be connected between the accessible dead metal parts (see 51.10) of the heater and the earth ground through a manual switch arranged to permit remote opening and closing of the circuit to the fuse.

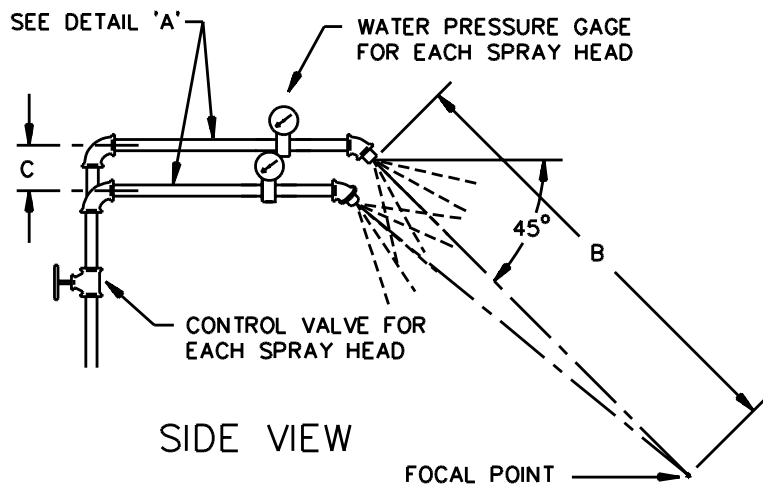
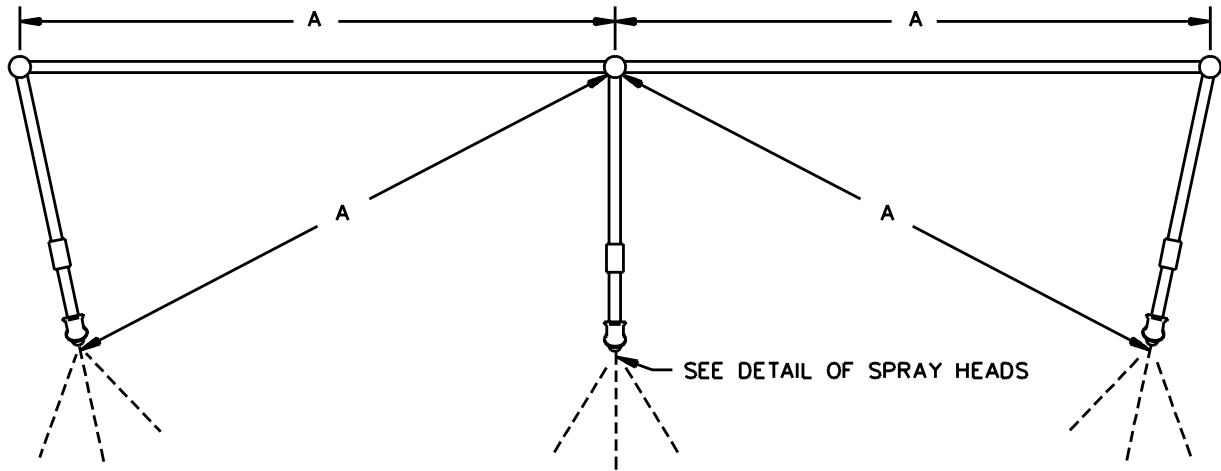
51.3 One representative movable heater is to be subjected to the test described in 51.5 and 51.6 and another is to be subjected to the test described in 51.7 – 51.9. For a heater employing a grounded (neutral) conductor, an additional representative heater for each of the tests is to be tested with the supply conductors reversed. A grounding conductor, if provided, is to be open during the tests. Each heater is to be operated at rated voltage and maximum rated input for 15 minutes immediately prior to being tested.

51.4 The hardwood surface mentioned in 51.5 and 51.7 is to consist of a layer of nominal 1-inch thick tongue-and-groove oak flooring nailed onto a layer of nominal 3/4-inch plywood or nominal 1-inch thick tongue-and-groove pine board subflooring. The complete surface is to rest on a concrete or equivalently nonresilient surface during the tests.

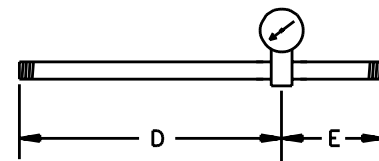
51.5 While the heater is energized and the switch to the fuse circuit is in the open position, the heater is to be lifted by its intended carrying means to a height of 2 feet (0.6 m) as measured from the hardwood test surface to the lowest point of the lowest point of the heater.

Exception: If the overall height of the heater is 2 feet or more (including its extended carrying handle, if any), the lowest point of the heater may be less than 2 feet but not less than 6 inches (75 mm) from the test surface, provided the top of such heater or the intended carrying means, whichever is the higher, is at least 4 feet (1.2 m) from the test surface.

Figure 49.1
Rain-test spray-head piping
PLAN VIEW



PIEZOMETER ASSEMBLY
DETAIL 'A'

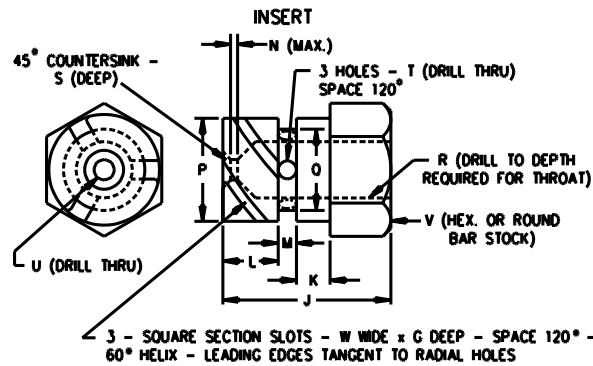
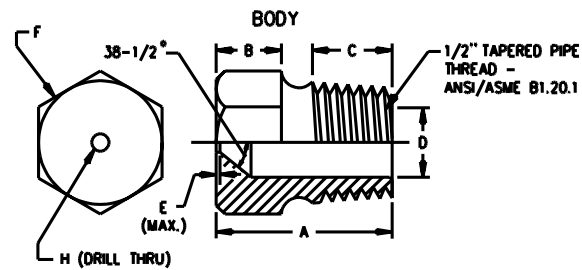
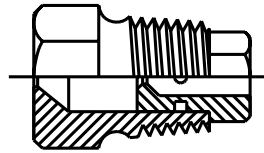


Item	inch	mm
A	28	710
B	55	1400
C	2-1/4	55
D	9	230
E	3	75

RT101E

Figure 49.2
Spray head

ASSEMBLY^a



Item	inch	mm	Item	inch	mm
A	1-7/32	31.0	N	1/32	0.80
B	7/16	11.0	P	.575	14.61
C	9/16	14.0	Q	.453	11.51
D	.578	14.68	R	.454	11.53
E	1/64	0.40	S	1/32	0.80
F	c	c	T	(No. 35) ^b	2.80
G	.06	1.52	U	(No. 40) ^b	2.50
H	(No. 9) ^b	5.0	V	5/8	16.0
J	23/32	18.3	W	0.06	1.52
K	5/32	3.97			
L	1/4	6.35			
M	3/32	2.38			

^a Nylon Rain-Test Spray Heads are available from Underwriters Laboratories

^b ANSI B94.11M Drill Size

^c Optional - To serve as a wrench grip.

RT100E

51.6 The heater is to be held in the intended carrying position and is then to be dropped onto the hardwood test surface that is covered with one layer of terry cloth. The switch to the fuse circuit is then to be closed and the fuse is to be observed for opening prior to and while being uprighted. This procedure is to be repeated two times, for a total of three drops.

51.7 The representative heater in the as-received condition is to rest on the hardwood surface covered with two layers of terry cloth. While energized at the rated voltage, the heater is to be tipped over five times in the manner specified in 51.8. The first tipover is to be onto the front face of the heater and then subsequent tipovers are to proceed in the clockwise or counterclockwise direction, one tipover onto face or side, with the last tipover again onto its front face. If the angle of critical balance (see 32.18) exceeds 60 degrees, the heater is not to be tipped over in this direction, but a total of five tipovers are to be made with each heater tested.

51.8 Each tipover is to be accomplished by tilting the heater quickly (in not more than 1 second), in one steady motion, to an angle greater than the angle of critical balance. The heater is then to be immediately released and allowed to fall freely by the force of gravity. While being tipped over, the switch to the fuse circuit is to be in the open position. After the heater comes to rest, the switch is to be closed and the fuse is to be observed for open circuiting prior to and while the heater is being uprighted.

51.9 If a part of the heater is structurally or functionally damaged by a tipover, described in 51.7 and 51.8, onto a face or side other than the front, but the damage has not caused the fuse to open, a second heater is to be subjected to five tipover tests with the first tipover in the direction that caused damage in the first test.

51.10 With reference to 51.2, a dead metal part is to be considered accessible if it does not comply with the accessibility requirements for uninsulated live metal parts in 8.4 and 8.10, and if the dead metal part can become energized by direct or indirect contact with a broken heating element.

52 Drop Test

52.1 A movable heater that is likely to be used in an elevated location, such as on a table, desk, or shelf (see 3.6) shall not:

- a) Emit sparks, flames, or molten metal,
- b) Cause the terry cloth to ignite,
- c) Open a 1/2-ampere nontime delay fuse, or
- d) Become a risk of fire or electric shock – see 41.7.4 – when subjected to a drop test in accordance with 52.3 – 52.8. If the heater is operational after the drop tests it shall be subjected to the Terry Cloth Band Drape Tests, 41.7.1 – 41.7.10.

52.2 If the heater is inoperative after the drop test with no adverse effects occurring in accordance with 52.1, three additional heaters are to be tested.

52.3 The heater is to be dropped three times through a distance of 3 feet (0.91 m) to strike a hardwood surface in the positions most likely to produce adverse results. The drop height is to be measured from the lowest point of the heater to the hardwood surface.

52.4 The hardwood surface mentioned in 52.4 is to be as described in 51.4, but additionally covered with two layers of terry cloth material.

52.5 Before conducting the drop, a nontime delay, 1/2-ampere fuse is to be connected between the accessible dead metal parts (see 51.10) of the heater and earth ground through a manual switch arranged to permit remote opening and closing of the circuit to the fuse. The grounded conductor and a grounding conductor, if provided, are to be treated as described in 51.3.

52.6 The heater is to be operated at maximum rated input for 15 minutes immediately prior to the drop. While energized and with the switch to the fuse circuit in the open position the heater is to be dropped so that it strikes the surface in a different position for each of the drops.

52.7 Following each drop, the heater is to be left energized in the position in which it comes to rest and the switch to the fuse circuit is to be closed. The heater is to be observed for the potential to ignite the terry cloth material and the fuse is to be observed for opening. The observation is to last for 15 minutes after which the heater is to be uprighted while energized and observed for opening of the 1/2 ampere fuse.

52.8 After completion of the last drop in accordance with 52.3 – 52.7, an evaluation is to be made concerning which of the positions in which the heater came to rest is most likely to produce the most adverse condition if left to lay in that position for a longer period of time. The heater is then to be placed in that position with the heater energized and the switch to the fuse circuit closed. The heater is to be observed for 7 hours for ignition of the terry cloth or opening of the fuse unless:

- a) No opening of the fuse and no discoloration of the terry cloth material is observed in 30 minutes after the drop. For this situation, it is assumed that no ignition will occur and the heater is to be uprighted in accordance with 52.7.
- b) Discoloration occurs, but no smoking or charring is observed in the next 2 hours. For this situation it is assumed that no ignition will occur and the heater is to be uprighted in accordance with 52.7.
- c) A manual reset type temperature limiting control or thermal cutoff de-energizes the heater circuits so that there is no longer a risk of fire or development of an electric shock.

Exception: This test need not be conducted if for each of the drops conducted in accordance with 52.3 – 52.7 it was observed that a tipover switch had de-energized the heater circuits.

53 Test for Permanence of Cord Tag

53.1 General

53.1.1 To determine compliance with 64.13, or SB15.2, as applicable, representative lengths of power supply cord each with a tag that have been subjected to the tests described in 53.2.2 – 53.3.1 shall comply with 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.

53.2 Test conditions

53.2.1 For each type of conditioning mentioned in 53.2.2 – 53.2.4, three representative lengths of power supply cord having a tag applied in the intended manner are to be used. If tags are applied by an adhesive, tests are to be conducted no sooner than 24 hours after application of the tag.

53.2.2 Three representative lengths of power supply cord each with a tag are to be tested as received.

53.2.3 Three lengths of power supply cord each with a tag are to be tested at the end of 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, following conditioning in an air-circulating oven at $60 \pm 1^\circ\text{C}$ ($140 \pm 1.8^\circ\text{F}$) for 240 hours.

53.2.4 Three lengths of power supply cord each with a tag are to be tested within 1 minute after exposure for 72 hours to a relative humidity of 85 ± 5 percent at $32 \pm 2^\circ\text{C}$ ($89.6 \pm 3.6^\circ\text{F}$).

53.3 Test method

53.3.1 Each representative device 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 3 pounds (13.3 N) is to be applied for 1 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 53.1.1(c), manipulation is permissible, such as straightening of the tag by hand. To determine compliance with 53.1.1(d), each tag is to be scraped ten times across printed areas and edges, with a force of approximately 2 pounds (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.

54 Protection Against Injury to Persons Test

54.1 Unless it is intended for hanging in a location (such as a ceiling) where it is not likely to be exposed to physical abuse, a panel of glass or similarly brittle material employed in a heater shall withstand, without cracking or breaking, the impact resulting from the test described in Figure 54.1.

54.2 A panel of glass or similarly brittle material employed in a heater shall withstand, without cracking or breaking, while in a fully heated condition, the application of:

a) A wet cloth, fully saturated with water at room temperature, wiped across the surface of the panel; and

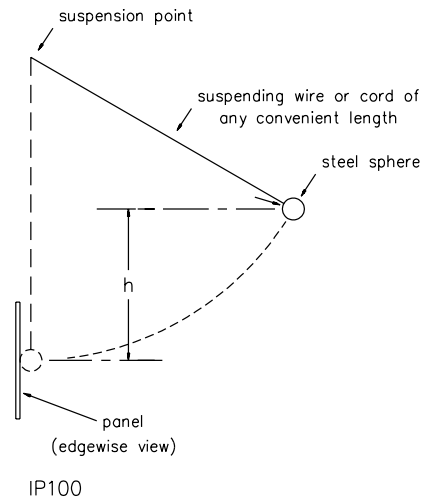
b) After the panel has returned to normal operating temperature, a fine spray of cold, tap water played across the surface of the panel.

54.3 A ceiling-hung heater employing glass or similarly brittle material integral with the element shall be provided with a guard that will prevent dropping of glass particle having:

a) A weight of more than 1-1/2 ounces (43 grams),

b) Any dimension larger than 1 inch (25.4 mm).

Figure 54.1
Impact test



NOTE:

The point of suspension is one inch (25.4 mm) in front of the panel, h is 16.25 inches (412.8 mm), the diameter of the steel sphere is 2 inches (50.8 mm), and the mass of the steel sphere is 1.18 lbs (0.535 kg mass) and it is to be released from rest.

55 Knob Securement Test

55.1 A removable knob, button, or pointer mentioned in 32.8 that is attached to its operating shaft by friction and not additionally secured by mechanical means, such as a set screw, shall not separate from the intended position on its operating shaft by application of a force of 3 pounds (13.34 N) applied for 1 minute as a straight pull in line with the shaft.

56 Strength of Adjustment Stop Test

56.1 A control or a switch on a heater intended for commercial/industrial use that is operated by a push, pull, slide, toggle or lever adjustment shall withstand a force of 20 pounds (89 N) for 15 seconds.

56.2 A control or a switch on a heater intended for use other than that of 56.1 that is operated by a push, pull, slide, toggle, or lever adjustment shall withstand a force of 10 pounds (45 N) for 15 seconds.

56.3 The heater shall not be damaged so as to cause a reduction of electrical spacings, erroneous indications of the control setpoint, or other conditions that may result in a risk of fire, electric shock, or injury to persons. The force is to be applied to the free end of the adjustment means, in line with the direction of its intended movement, and it is to be applied in each direction of the movement with the control adjustment set at the extreme position in the direction of the movement.

56.4 Switches and controls operated by a rotary adjustment when mounted in the product, shall withstand the torque specified in 56.5 and shall not be damaged so as to cause a reduction of electrical spacings, an increase in a temperature setting, displacement of the control with respect to the mounting surface, or other condition that may result in a risk of fire, electric shock, or injury to persons.

56.5 With reference to 56.4, a torque is to be applied for 15 seconds to the adjustment knob in the direction of intended operation in accordance with the following:

- a) For a control provided with a knob where D_1 is 1 inch (25.4 mm) or less, the applied torque is to be 9 pound inches (1.0 N·m) if the heater is intended for commercial/industrial use or 7 pound-inches (0.8 N·m) if it is intended for all other uses.
- b) For a control provided with a knob where D_1 is more than 1 inch, the torque applied is to be determined in accordance with the following formula:

$$T = \frac{D_1}{D} K$$

In which:

T is the torque to be applied in pound inches (N·m),

D_1 is the actuator diameter for a round actuator or grip length for a nonround actuator in inches (mm),

D is 1 inch (25.4 mm), and

K is 9 pound-inches (1.0 N·m) for a heater intended for commercial/industrial use or 7 pound-inches (0.8 N·m) for a heater intended for all other uses.

57 Hydrostatic Test

57.1 With regard to 11.1, a part that is subjected to pressure (including the vapor pressure of a superheated fluid) during intended or abnormal operation shall withstand without failure, a pressure equal to five times the working pressure.

57.2 Two representative parts are to be filled with water to exclude air and are 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 part bursts or leaks, except as indicated in 57.3.

57.3 Leakage at a gasket during the hydrostatic-pressure test is not considered to constitute a failure unless it occurs at a pressure 40 percent or less of the required test value.

58 Strain Relief Test

58.1 With regard to 16.11, strain relief shall be provided to prevent mechanical stress on a flexible supply cord from being transmitted to terminals, splices or interior wiring.

58.2 When tested in accordance with 58.3, the strain-relief means provided on the flexible cord shall withstand for 1 minute, without displacement, a direct pull of 35 pounds force (155 N force) applied to the cord, with the connections within the heater disconnected.

58.3 A 35-pound (15.9 kg) weight is to be suspended on the cord and so supported by the heater that the strain-relief means will be stressed from any angle which the construction of the heater permits. The strain relief is not acceptable if, at the point of disconnection of the conductors, there is movement of the cord that indicates stress on the connection would have resulted.

59 Permanence of Marking

59.1 The marking in Section 60 shall, unless otherwise indicated, be permanently applied by means such as:

- a) Etched, molded, die-stamped or paint-stenciled on the enclosure,
- b) Stamped or etched on metal, or
- c) Indelibly stamped lettering on pressure-sensitive labels secured by adhesive.

59.2 Pressure-sensitive labels secured by adhesive shall comply with the Standard for Marking and Labeling Systems, UL 969.

59.3 Usage of the heater shall be considered when determining the permanence of a marking.

MANUFACTURING AND PRODUCTION TESTS

60 Production-Line Dielectric Voltage-Withstand

60.1 Each heater 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 hertz;

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

60.2 The production-line test shall be in accordance with either Condition A or Condition B of Table 60.1.

Table 60.1
Production-line conditions

Heater voltage rating	Condition A		Condition B	
	Potential, Volts	Time, Seconds	Potential, Volts	Time, Seconds
0 – 250	1000	60	1200	1
Above 250 volts	1000+2V ^a	60	1200+2.4V ^a	1

^a Maximum marked voltage but not less than 250 volts.

60.3 The heater may be in a heated or unheated condition for the test.

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

Exception No. 1: A part such as a snap cover that would interfere with conducting 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 heater.

60.5 The test equipment shall include a transformer having an essentially sinusoidal output, a means of indicating the test potential, an audible or visible indicator of electrical breakdown, and either a manual reset device to restore the equipment after electrical breakdown or an automatic reject feature activated by a dielectric breakdown.

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

60.7 If the output of the test equipment transformer is 500 volt-amperes or larger, the test potential may be indicated by:

- a) A voltmeter in the primary circuit or in a tertiary winding circuit,
- b) By a selector switch marked to indicate the test potential, or
- c) 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.

60.8 Test equipment other than that described in 60.5 – 60.7 may be used if found to accomplish the intended factory control.

60.9 During the test, the primary switch is to be in the on position, both sides of the primary circuit of the heater 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 heater (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 switch is in the on position, or when a primary switch is not used.

61 Production-Line Grounding Continuity

61.1 The manufacturer shall test each heater provided with a power-supply cord incorporating a grounding conductor to determine that electrical continuity exists between an exposed dead metal part of the heater and the grounding blade of the attachment plug as required by 35.2.

61.2 For the test mentioned in 61.1, the manufacturer is to employ an indicating device (an ohmmeter, a low-voltage battery-and-buzzer combination, or similar device).

62 Production-Line Tip Over

62.1 The manufacturer shall test each heater that employs a tip-over switch to determine that the switch functions as intended after assembly in the heater. The heater shall be energized during this test.

RATINGS

63 Details

63.1 A heater 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 heater is designed 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 any appropriate single voltage or voltage range such as: 100 – 120, 208, 220 – 240, 254 – 277, 440 – 480 and 600.

63.2 If a heater includes an attachment-plug receptacle that is not intended as a disconnecting means for any part of the heater or necessary accessory and that may, therefore, serve as a general-use outlet, the added load that the receptacle may impose on the heater and its supply connections (not less than 660 watts or 6 amperes per pair of slots) shall be taken into consideration in determining the electrical rating of the heater.

63.3 The requirement in 63.2 does not apply to an attachment-plug receptacle for general use.

MARKINGS

64 Details

64.1 A heater shall be permanently marked, in such location that the marking will be plainly visible with:

- a) Listee's name, trade name or trademark,
- b) The catalog number or the equivalent,
- c) The date or other dating period of manufacture not exceeding any three consecutive months, and
- d) The complete electrical rating (in accordance with 63.1). A heater intended for use on alternating current only or direct current only shall be marked to so indicate.

Exception No. 1: The manufacturer's identification may be in a traceable code when the heater is identified by a brand or trademark owned by a private labeler.

Exception No. 2: The date of manufacturer may be abbreviated or in a nationally accepted conventional code or a code affirmed by the manufacturer. The code shall not require reference to the manufacturer's records to determine when the heater was manufactured. A ten year recycle period for the date code is acceptable for household products and a twenty year recycle period is acceptable for other products.

64.2 If a manufacturer produces or assembles heaters at more than one factory, each finished heater shall have a distinctive marking – which may be in code – to identify it as the product of a particular factory.

64.3 Each individual heating element or unit that is a part of a heater and is replaceable in the field shall be plainly marked with its electrical ratings in amperes or watts, and also in volts.

64.4 A heater shall bear the cautionary marking shown in Figure 64.1. The marking shall be located so that it is clearly visible if servicing is attempted on the heater and shall have the minimum dimensions specified in 64.16. The height of the symbols shall be at least 1 inch (25.4 mm) and they shall be a color that contrasts with that of the background and that matches the lettering.

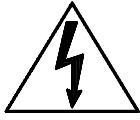
Exception: A heater that complies with 8.10 and 8.12 need not comply with this requirement.

64.5 A heater whose acceptable performance depends upon its proper location or position shall be marked (such as "Top " or "Bottom ") to indicate the way in which it is to be installed or used, unless such position is obvious from the external appearance of the heater.

64.6 If the design of a heater contemplates disassembly by means of a tool for the purpose of cleaning or similar servicing by the user (including replacement of a thermal cutoff on a commercial-industrial heater), and if such disassembly involves the exposure of persons to unintentional contact with any normally enclosed or protected live part, the heater shall be plainly marked with a warning, that such servicing should be done only while the heater is disconnected from the supply circuit. See also 8.10.

64.7 If the servicing or replacement of a component of a heater in the field requires the removal or disconnection of any safety device, a caution marking shall appear on or adjacent to the device, calling attention to the fact that it should be repositioned in the proper location. The manufacturer's instructions provided with the heater shall call specific attention to this feature.

Figure 64.1
Cautionary marking



SA1965A

**CAUTION
RISK OF ELECTRIC SHOCK
DO NOT OPEN
NO USER-SERVICEABLE PARTS INSIDE**



64.8 If compliance of a commercial-industrial type heater with any of the requirements in this standard depends upon the functioning of a field-replaceable thermal cutoff (fusible link):

- a) The thermal cutoff (fusible link) shall be marked with the name or trademark of the manufacturer of the link, and its catalog designation or the equivalent, and
- b) The heater shall be marked with a statement that a replaceable link should be as indicated in (a).
- c) The letter size shall be as indicated in 64.16.

64.9 If a supplementary type fuse is used for motor-overload protection, the heater shall be marked with the type and rating of the fuse to be used including the fuse manufacturer's or private labeler's name and catalog designation. The letter size shall be as indicated in 64.16.

64.10 A heater that is rated between 2 kilowatts and 6 kilowatts and less than 250 volts and is intended only for commercial/industrial use shall be marked with the word "WARNING" and the following or the equivalent: "Risk of fire. Do not use as a residential or household heater." This statement shall be legible and located so that it is visible during and after the heater is installed in accordance with the manufacturers instructions. The marking shall also appear on the heater carton (see 65.5.2). The letter size shall be as indicated in 64.16.

Exception: A heater that complies with the requirements for both residential and commercial/industrial heaters need not comply with this marking requirement.

64.11 The hanging-bracket kit for a wall-hung or ceiling-hung heater, mentioned in 16.2 shall be identified by a model, catalog, or part number. The kit shall also be marked "For use with heater Model" to indicate the heater or heaters with which the kit is intended for use and the heater shall be permanently marked "For wall hanging (or ceiling-hanging), use wall-hanging (or ceiling-hanging) accessory kit No." except that an equivalent marking may be used in either case.

Exception: If the hanging brackets are shipped with the heater and clear hanging instructions are provided, the marking may be eliminated.

64.12 An inherently thermally protected motor provided on a heater shall be marked "Thermally protected," except that if the inherent protection is for locked rotor only the marking shall be "Thermally protected L." An impedance-protected motor provided on a heater shall be marked "Impedance protected." Motors rated 100 Watts, or less, may use the abbreviations T.P. or Z.P., as appropriate.

64.13 Except for a ceiling-hung heater, a heater of the radiant type having a visibly glowing element (see 3.15) shall employ the following markings:

a) Permanent marking on a surface of the heater that is visible from the front of the heater, with the word "WARNING" and the following or equivalent wording: "Risk of Fire – keep combustible material such as furniture, papers, clothes, and curtains at least 3 feet (0.9 m) from the front of the heater and away from the sides and rear." This marking shall be readily visible and shall have the minimum dimensions specified in 64.16.

b) A tag, permanently attached to the power-supply cord (see 64.14), that shall include at least the following or equivalent instructions:

"WARNING – TO REDUCE THE RISK OF FIRE:

1) Do not place any objects such as furniture, papers, clothes, and curtains closer than 3 feet to the front of the heater and keep them away from the sides and rear when the heater is plugged in.

2) Do not place the heater near a bed because objects such as pillows or blankets can fall off the bed and be ignited by the heater.

3) Always unplug the heater if it is not being used.

4) Avoid the use of an extension cord because the extension cord may overheat and cause a risk of fire. However, if you have to use an extension cord, the cord shall be No. ___ AWG minimum size and rated not less than ___ watts.

DO NOT REMOVE THIS TAG!"

The above information is to be legibly printed and should contrast with the background. If both sides of the tag are utilized to incorporate the required marking, the text of the marking shall be arranged so that it is obvious that the marking is started on one side and is continued on the other side of the tag. The statements "WARNING – TO REDUCE THE RISK OF FIRE" and "DO NOT REMOVE THIS TAG!" shall be in letters at least 3/16 inch (4.8 mm) in height. The remaining text shall be in letters of at least 1/16 inch (1.6 mm) in height.

Exception: The marking of "3 feet" in the above markings may be reduced if the marking is revised to replace the words "WARNING – TO REDUCE THE RISK OF FIRE" with "DANGER – TO AVOID FIRE."

64.14 With reference to item 64.13(b), the warning tag shall be permanently affixed to the power-supply cord, no more than 6 inches (152 mm) from the attachment plug and shall be made of substantial material (cardboard, cloth, plastic, or the equivalent) to provide mechanical strength and to prevent easy removal. The tag shall be of a size that facilitates legibility of the required markings, and all exposed surfaces shall have a clear plastic overlay, or the equivalent, to protect the markings. The tag shall be either of the following forms:

- a) A flag tag having a hole to permit securement to the power-supply cord by a plastic strap or equivalent means. The strap shall not be removable without cutting.
- b) A flag-type with an adhesive back. The tag is to be wrapped tightly once around and is to adhere to the supply cord. The ends of the tag are to adhere to each other and project as a flag. The required markings are to be positioned on the projecting flag portion of the tag.

The permanence of the warning tag shall be determined in accordance with Test for Permanence of Cord Tag, Section 53.

64.15 A movable or wall-hung heater of a type other than covered in 64.13 shall be marked on a surface that is visible from the front of the heater with the following wording: "CAUTION – High temperature, keep electrical cords, drapery, and other furnishings at least 3 feet (0.9 m) from the front of the heater and away from the side and rear." The marking shall be readily visible and shall have the minimum dimensions specified in 64.16.

Exception No. 1: The following marking may be substituted for the marking described above, if during intended operation, the temperature at any point on the surface of the heater does not exceed 121°C (249.8°F). "DANGER – High temperatures may be generated under certain abnormal conditions. Do not partially or fully cover or obstruct the front of this heater."

Exception No. 2: The caution marking described above is not required on a heater if, during the Normal Temperature Tests and Abnormal Operation Tests, Sections 39 and 41, the temperature at any point on the surface of the heater does not exceed 121°C (249.8°F).

Exception No. 3: A wall-hung heater need not be marked with the cautionary marking provided it complies with the requirements in 41.8.2.1 – 41.8.3.1.

Exception No. 4: The marking of "3 feet" in the above marking may be reduced if the marking is revised to replace the word "CAUTION" with "DANGER – TO AVOID FIRE."

64.16 With respect to 64.8, 64.9, 64.13, 64.15, 64.17, and 64.18 readily visible means visible from a point 5 feet (1.5 m) above the floor and between 1 and 4 feet (0.3 and 1.2 m) away from the front surface of the heater when the heater is placed in the intended use location. The marking shall be in letters not less than 1/8 inch (3.2 mm) in height and shall be of a permanent type and in a color that contrasts with that of the enclosure or background.

Exception No. 1: The location of the marking on a wall-supported heater provided with an adjustable decorative fire curtain shall be considered acceptable if it complies with 64.13 with the fire curtain in the full open position.

Exception No. 2: The word "CAUTION" or "WARNING" shall be readily visible on the front of the heater but the remainder of the wording may be in an adjacent location clearly connected to the "CAUTION" or "WARNING" word.

64.17 For a movable heater that is considered likely to be used in an elevated location (see 3.6), the markings specified in 64.13 and 64.15 shall be readily visible with the heater in the intended use location, which is assumed to be on the floor and also at any point between and including 2.5 and 5 feet (0.75 and 1.5 m) above the floor.

64.18 If the guard of a heater is removable (for example, if it is intended to be removed for shipping, storage, and the like), the heater shall be plainly and legibly marked, in a location where the marking will be readily visible after the heater has been installed as intended, with a warning that it should not be operated unless the guard is in place. The letter size shall be as indicated in 64.16.

64.19 If a drive-in-theater heater for outdoor use (as described in 49.2) is provided with a shelter, the heater shall be plainly marked "Replace heater in shelter when not in use."

64.20 A heater referenced in Exception No. 2 of 36.1 shall be marked with the word "CAUTION" and the following or equivalent: "Risk of Fire – Do Not Operate Without Legs (Base) Attached." The marking shall comply with the requirements in 64.16.

64.21 If required overcurrent protective devices or contactors are provided as a separate assembly, the heater shall be marked to indicate that it is to be used only with this separate assembly.

64.22 If replaceable fuses are provided for overcurrent protection of a control circuit conductor or transformer (see 26.1.2), the heater shall be marked with the maximum current rating of the fuse. The marking shall be visible when the cover or door of the fuse compartment is opened. If a supplementary type fuse is provided, the marking shall also include the fuse manufacturer's or private labeler's name, catalog designation, and fuse voltage rating.

64.23 If a Class G fuse is provided, or if the fuseholder will accept a Class H fuse, but a different class of fuse was used during the temperature test on the equipment, the marking specified in 64.22 shall also include the fuse class.

64.24 With reference to 64.22 and 64.25, the type of overcurrent protective device shall also be specified in the marking if required in order to comply with the requirement in 43.1.

64.25 If in accordance with the exception to 26.4.4 or with 26.5.6, overcurrent protection is not provided as part of the equipment, the equipment shall be marked with the maximum rating of the overcurrent device or devices for the supply circuit. The rating of the overcurrent device shall be based on the ampacity of the supply circuit conductors, as determined from ampacity tables contained in the National Electrical Code, ANSI/NFPA 70. The marking shall appear on the wiring diagram, adjacent to the field wiring terminals, or on the unit nameplate. See 64.24.

65 Instructions for Use and Care

65.1 General

65.1.1 The requirements in this section are applicable only to freestanding heaters.

65.1.2 An instruction manual or the equivalent, shall be provided with each heater. The manual shall specifically warn the user against potential risk of fire, electric shock, and injury to persons and state the precaution that should be taken to guard against each such risk. The instructions relating to the risk of fire, electric shock, and injury to persons shall be a permanent part of the manual, but separated in format from the other instructions and shall appear before the operating instructions in the manual. The upper

case letters in the instructions relating to the risk of fire, electric shock, and injury to persons shall be not less than 1/12 inch (2.1 mm) high and the lower case letters shall not be less than 1/16 inch (1.6 mm) high.

65.1.3 The instruction manual shall include instructions or illustrations to identify important features related to reducing the risk of fire, electric shock, and injury to persons.

65.1.4 The instruction manual shall include the instructions specified in 65.2.1; and the words "IMPORTANT INSTRUCTIONS" and "SAVE THESE INSTRUCTIONS" shall be in upper case letters not less than 3/16 inch (4.8 mm) high.

65.1.5 Unless otherwise indicated, the text of the instructions shall be verbatim, or in equally definitive terminology.

Exception: If a specific conflict in the application to a product exists, or if the wording would be inappropriate, appropriate variations from the specified wording may be used.

65.1.6 Wording in parentheses is intended to be explanatory, indicating such factors as options, alternatives, exceptions, or cross-references.

65.1.7 The items may be numbered. In the list of items the first shall be "Read all instructions before using the heater," and the last shall be "SAVE THESE INSTRUCTIONS." Other important instructions relating to the risk of fire, electric shock, and injury to persons considered appropriate by the manufacturer may be inserted.

65.2 Important instructions

65.2.1 The instruction manual shall incorporate all required cautionary markings for the heater specified in the Marking Details, Section 64, and shall also include at least the following general instructions, as appropriate.

IMPORTANT INSTRUCTIONS

When using electrical appliances, basic precautions should always be followed to reduce the risk of fire, electric shock, and injury to persons, including the following:

- 1) Read all instructions before using this heater.
- 2) This heater is hot when in use. To avoid burns, do not let bare skin touch hot surfaces. If provided, use handles when moving this heater. Keep combustible materials, such as furniture, pillows, bedding, papers, clothes, and curtains at least ^a ___ feet (^a ___ m) from the front of the heater and keep them away from the sides and rear.

^aClearance distance is to be determined in accordance with 64.13 or 64.15.
- 3) Extreme caution is necessary when any heater is used by or near children or invalids and whenever the heater is left operating and unattended.
- 4) Always unplug heater when not in use. (This item may be omitted if the heater is provided with a clock-operated switch).

- 5) Do not operate any heater with a damaged cord or plug or after the heater malfunctions, has been dropped or damaged in any manner. Return heater to authorized service facility for examination, electrical or mechanical adjustment, or repair.
- 6) Do not use outdoors. (Omitted if the heater is intended for outdoor use.)
- 7) This heater is not intended for use in bathrooms, laundry areas and similar indoor locations. Never locate heater where it may fall into a bathtub or other water container.
- 8) Do not run cord under carpeting. Do not cover cord with throw rugs, runners, or similar coverings. Arrange cord away from traffic area and where it will not be tripped over.
- 9) To disconnect heater, turn controls to off, then remove plug from outlet.
- 10) Connect to properly grounded outlets only. (This item may be omitted if the heater is not provided with a grounding type attachment plug.)
- 11) Do not insert or allow foreign objects to enter any ventilation or exhaust opening as this may cause an electric shock or fire, or damage the heater.
- 12) To prevent a possible fire, do not block air intakes or exhaust in any manner. Do not use on soft surfaces, like a bed, where openings may become blocked.
- 13) A heater has hot and arcing or sparking parts inside. Do not use it in areas where gasoline, paint, or flammable liquids are used or stored.
- 14) Use this heater only as described in this manual. Any other use not recommended by the manufacturer may cause fire, electric shock, or injury to persons.
- 15) Avoid the use of an extension cord because the extension cord may overheat and cause a risk of fire. However, if you have to use an extension cord, the cord shall be No. ___ AWG minimum size and rated not less than ___ watts.
- 16) This heater may include an audible (a visual) alarm to warn that parts of the heater are getting excessively hot. If the alarm sounds (flashes), immediately turn the heater off and inspect for any objects on or adjacent to the heater that may cause high temperatures. **DO NOT OPERATE THE HEATER WITH THE ALARM SOUNDING (FLASHING).** (Omitted if an alarm is not required per Alarms, Section 29.)
- 17) "SAVE THESE INSTRUCTIONS"

65.2.2 With reference to 65.2.1(15), the minimum size and wattage values shown shall be 1.25 times the heater wattage rating or 1.25 times the heater current rating times the heater test voltage. The voltage used in the calculation shall be that used for the Normal Temperature Test as determined by Table 39.2. The size of the cord shall be obtained from Table 400-5(a) of the National Electrical Code, ANSI/NFPA 70. If a heater rated 110 – 120 volts employs a grounding type cord and plug, the instructions shall also specify that the extension cord shall be a 3 wire cord with a grounding type cord and plug connector.

65.3 User instructions

65.3.1 The instruction manual shall also include the following in a separate section or sections:

- a) Instructions and cautionary statements for usage cleaning, user-maintenance, operations recommended by the manufacturer, such as lubrication or nonlubrication, and a warning to the user that any other servicing should be performed by an authorized service representative.
- b) The function of indicator lights and symbols used for switches or manually operated controls shall be explained.
- c) Any heater employing a manually reset control shall be provided with instructions to the user regarding its operation.
- d) Specific instructions for the proper method of cord storage, total heater storage, and the like when the heater is not in use.

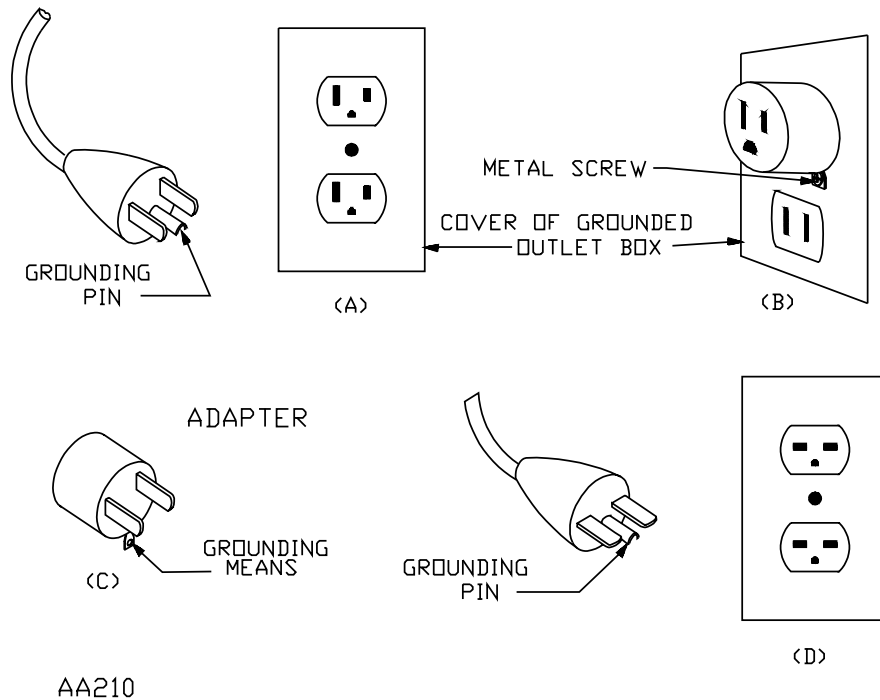
65.4 Grounding instructions

65.4.1 The instruction manual of grounded heaters shall include the following or equivalent wording:

(In the case of a heater rated for a nominal 120 volts.) This heater is for use on 120 volts. The cord has a plug as shown at A in Figure 65.1. An adapter as shown at C is available for connecting three-blade grounding-type plugs to two-slot receptacles. The green grounding lug extending from the adapter must be connected to a permanent ground such as a properly grounded outlet box. The adapter should not be used if a three-slot grounded receptacle is available.

(In the case of a heater rated for a nominal 240 or 208 volts.) This heater is for use on 240 (or 208) volts. The cord has a plug as shown in D in Figure 65.1. No adapter is available for this blade configuration, and none should be used. The type outlet is a 240 (or 208) volt grounding outlet. When properly installed, it provides a ground connection through the cord to the heater to protect the operator from electric shock.

Figure 65.1
Grounding methods



65.5 Heater carton information

65.5.1 At least the following information pertaining to the heater features and its use conditions shall be included on the external surface of the packaging of a heater. All information shall be grouped together and appear on one side, except the bottom, of the packaging.

- a) Voltage and ampere or wattage rating.
- b) The specific location, if the intended location of the heater is specific (such as floor only, wall mounted only, wall insert, and the like).
- c) Information pertaining to the use of an extension cord. See 65.2.1(15).
- d) The type of cord and plug receptacle configuration (can be described or shown pictorially), if other than standard 120 volts/15 or 20 amperes configuration.
- e) Clearances to be maintained from combustibles, giving examples of combustibles. See 65.2.1(2).

Exception: This information need not be provided if Exception No. 1, 2, or 3 to 64.15 apply.

- f) A statement specifying that the heater is not to be used in wet or moist locations [see 65.2.1(7)], unless the heater is identified as suitable for such use.

65.5.2 If a heater is marked according to 64.10, the heater carton shall be marked with the word "WARNING " and the following or equivalent: "Risk of fire. Do not use as a residential or household heater."

Exception: A heater that complies with the requirements for both residential and commercial/industrial heaters need not comply with this marking requirement.

SUPPLEMENT SA - CERTAIN RADIANT ROOM HEATERS

INTRODUCTION

SA1 Scope

SA1.1 These requirements apply to movable electric room heaters of the radiant type as described in SA1.2. These requirements add to the applicable requirements in the body of this Standard.

SA1.2 A heater covered by these additional requirements shall comply with all of the following items:

- a) The enclosure, excluding a projecting guard or support, shall be less than 5 inches (127 mm) in depth.
- b) The ratio of the heater's overall length to height, excluding handles, shall be more than 2 to 1, or 3 to 1 for a heater higher than 2 feet (610 mm).
- c) A heater shall have a visibly glowing heating element as defined in 3.15.
- d) The heater shall not be sold or recommended for use as a baseboard heater.

CONSTRUCTION

SA2 Enclosure

SA2.1 General

SA2.1.1 An electrical part shall be so located or enclosed that protection against unintentional contact with any uninsulated live part is provided. Insulated motor brush caps do not require additional enclosures.

SA2.1.2 In determining if an opening in an enclosure is acceptable, consideration is to be given to:

- a) The proximity of any uninsulated live part and
- b) The possibility of the emission of burning insulation, molten metal, and the like through the opening.

SA2.1.3 A moving part such as a fan blade, blower wheel, pulley, or belt that may cause injury shall be enclosed or guarded.

SA2.1.4 If the removal of a door, panel, or shield exposes a moving part that involves risk or injury to persons:

- a) The opening or removal of the door, panel, or shield shall require the use of a tool,
- b) An interlocking device shall shut off the mechanism, or
- c) A warning marking shall be displayed in letters not less than 1/8 inch (3.2 mm) high that reads essentially as follows:

DANGER – Moving parts inside that involve risk or injury to persons. Shut off the (equipment) before (removing-opening) this (cover-door).

SA2.1.5 The distance from an opening in a required guard or enclosure to the moving part mentioned in SA2.1.3 shall be in accordance with Table SA2.1 but the minor dimension of the opening shall not in any case exceed 1 inch (25.4 mm). For an opening having a minor dimension intermediate between two of the values included in Table SA2.1, the distance from the opening to the moving part shall be not less than that found by appropriate interpolation between the corresponding values in the right-hand column of Table SA2.1. The minor dimension of the opening is determined by the largest hemispherically tipped cylindrical probe that can be inserted through the opening with a force of 5 pounds (22.2 N).

Table SA2.1
Openings

Minor dimension of opening		Minimum distance from opening to moving part	
inches ^a	mm	inches	mm
1/4	6.4	1/2	12.7
3/8	9.5	1-1/2	38.1
1/2	12.7	2-1/2	63.5
3/4	19.1	2-1/2	114
1	25.4	6-1/2	165

^a Openings less than 1/4 inch (6.4 mm) are not to be considered.

SA2.1.6 If a moving part cannot be contacted through the opening because of fixed components, including baffles, compliance with SA2.1.3 and SA2.1.5 is not required.

SA2.1.7 A part of a heater such as an enclosure, frame, guard, or handle that is subject to contact in operation and user servicing shall be free of sharp corners, edges, or projections.

SA2.1.8 A handle intended to support or carry more than 20 pounds (9.10 kg) shall have a gripping surface at least 4 inches (102 mm) long.

SA2.1.9 A handle shall be fastened so that it cannot be partly or completely removed without the use of a tool.

SA2.1.10 A handle used for support of a movable heater shall be able to sustain four times the weight of the heater. The appropriate load shall be uniformly applied over a 3-inch (76-mm) length at the center of the handle, gradually increased to the test value over a period of 5 to 10 seconds, and maintained at the test value for 1 minute. The load shall be supported with no evidence of damage to the handle such as separation, cracking, or permanent deformation. For this test the heater may be inverted and supported so that the test weight can be applied directly to the handle.

SA2.1.11 If more than one handle is furnished on the heater, the load indicated in SA2.1.10 shall be distributed between the handles. The distribution of the load shall be determined by measuring the percentage of the weight of the heater supported by each handle with the heater in the normal carrying condition.

SA2.1.12 If a heater is furnished with more than one handle and the heater can be carried by one handle alone, each handle shall be capable of supporting the load described in SA2.1.10.

SA2.2 Guards

SA2.2.1 A slot opening in the outer enclosure of a heater, if more than 6 inches (152 mm) in length, shall be provided with wire guards or the equivalent at intervals such that no section of the slot is uninterrupted for a distance of more than 6 inches (152 mm).

Exception: The guard is not required on a heater that complies with the requirement in SA14.1.

SA3 Stability

SA3.1 A movable heater shall return to its intended at-rest position on a level surface after being:

- a) Tipped in any direction to an angle of 10 degrees from horizontal, or
- b) Subjected to a force of 25 percent of the weight of the heater externally applied in a horizontal direction to the point on the heater providing the greatest tendency to overturn it.

SA3.2 The test is to be conducted on the unit when placed under the most unfavorable conditions. The heater shall be arranged with all doors and other appurtenances in the position tending to decrease stability. The legs or other points of support may be blocked to prevent the unit from sliding during the application of the externally applied force.

SA4 Supply Connections

SA4.1 A movable heater shall be provided with a directly attached flexible cord and an attachment plug. The exposed length of the cord (including fittings) shall not be less than 6 feet (1.8 m) and not more than 8 feet (2.4 m).

SA4.2 The flexible cord shall be as indicated in Table SA4.1 or shall be of an equivalent type.

Table SA4.1
Acceptable types of cord

Temperature of more than 121°C (250°F) on any surface likely to be contacted by cord	Temperature of 121°C (250°F) or less on all surfaces likely to be contacted by cord ^a
HPD, HPN, HSJO, HSJ	SP – 2, SPT – 2, SVO, SV, SVTO, SVT, SJO, SJ, SJTO, SJT
^a Cords of the types indicated in the first column may also be used.	

SA5 Internal Wiring

SA5.1 The internal wiring shall consist of wires of the size and type rated for the particular application, when considered with respect to the temperature and voltage to which the wiring is likely to be subjected, with respect to its exposure to oil or grease, and with respect to other conditions of service to which it is likely to be subjected. The thickness of the insulation shall be 1/32 inch (0.8 mm) except that it may be not less than 1/64 inch (0.4 mm) if the wire is provided with a braid or jacket not less than 1/64 inch (0.4 mm).

SA5.2 The temperature limit marked on the insulation of an insulated conductor shall not exceed the temperature limit applicable to that material.

SA6 Automatic Controls and Control Circuits

SA6.1 If a temperature control, mode control, or both in a heater has a marked "off" position, or another wording (such as "no heat," "cold," "O" or similar wording) that conveys the same meaning as the word "off," it shall disconnect the element or elements it controls from all ungrounded conductors of the power-supply circuit when placed in that position, that is, when not cycling.

SA6.2 If a temperature control has a marked position as described in SA6.3, it shall not function as a temperature control – that is, it shall not respond to temperature changes – while the actuating members is in that position.

SA6.3 The requirement in SA6.2 applies to a temperature control that is marked:

- a) With an "off" position, or
- b) With another wording (such as "no heat," "cold," "O" or similar wording) that conveys the same meaning as the word "off."

SA6.4 A temperature regulating control that does not reclose (remains open) when cooled to a temperature of minus 35°C (minus 31°F) is acceptable with respect to the requirements in SA6.2.

SA6.5 A temperature-limiting control shall be acceptable for use with baseboard heaters and shall not function during the temperature test.

SA7 Spacings

SA7.1 Spacings in a heater shall be in accordance with Tables SA7.1 and SA7.2.

Exception: The spacings specified in Tables SA7.1 and SA7.2 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. See 4.1.

Table SA7.1
Minimum acceptable spacings at field-wiring terminals and at fuseholders and thermal cutoffs^{a,b}

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

^a The spacings do not apply to connecting straps or busses extending away from wiring terminals, fuseholders or thermal cutoffs. Such spacings are to be evaluated under Table S7.2.

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

Table SA7.2
Minimum acceptable spacings through air or over surface at points other than fuseholders, thermal cutoffs, or inside motors^a

Parts involved	Potential involved, volts	inch	mm
Between uninsulated live parts of opposite polarity; and between a rigidly mounted uninsulated live part and a dead metal part that either is exposed for persons to contact or may be grounded	0 – 250	1/16 ^b	1.6 ^b
	251 – 300	1/4 ^{c,d}	6.4 ^{c,d}
^a If an uninsulated live part is not rigidly supported, or if a movable dead metal part is in proximity to an uninsulated live part, the construction shall be such that at least the minimum acceptable spacing is maintained under all operating and under all normal conditions of handling. ^b The spacing from an uninsulated live part to the metal enclosure shall be not less than 1/4 inch (6.4 mm). ^c Film-coated-insulated wire is considered to be uninsulated live part. However, a spacing of not less than 3/32 inch or 2.4 mm (over the surface and through air) is acceptable between a dead metal part and film-coated insulated wire rigidly supported and held in place on a motor coil. ^d A spacing of 1/16 inch (1.6 mm) is acceptable at the heating element only.			

PERFORMANCE

SA8 General

SA8.1 With respect to footnote^b to Table SA9.1, if a heater is intended to be shipped with the legs detached, the tests are to be conducted with the legs in place, as well as detached.

SA8.2 If the removal of feet or other supports results in operation of protective devices during the temperature test, such operation is not considered to be unacceptable if, when the test is repeated with the parts replaced in the intended manner, there is no operation of the protective devices.

SA9 Normal Temperature Test

SA9.1 General

SA9.1.1 For both normal temperature and abnormal operation tests, the heater is to be located in a wall angle as described in SA9.1.2.

SA9.1.2 A heater is to be placed in the intended manner against the black-painted surface of a wall consisting of 3/8 inch (9.5 mm) thick plywood fastened to both shorter sides of trade size 2 by 4 inch vertical wooden studs on 16 inch (0.4 m) centers. Two or more such walls are to be fastened together to form a 90 degree angle, and the height and length of the walls are to be such that they extend not less than 2 feet (0.6 m) beyond the physical limits of the heater. The heater is to be located as close to the sides of the wall angle as its construction permits, and it is to be so placed relative to the walls that maximum heating occurs on the latter.

SA9.1.3 The temperature limiting control of a heater shall not function when the heater is operated in accordance with SA9.1.4.

SA9.1.4 A heater shall be tested under the applicable conditions in accordance with SA9.1.2 and the following.

a) If carpeting or equivalent material can be laid flat on the floor under the heater between the supporting legs, the heater shall be tested with such materials so placed and pushed as far back as the construction permits.

b) If guards or other design features prevent carpeting or equivalent material from being laid flat on the floor under the heater, the test shall be made with such material as close to the heater as the heater construction permits.

SA9.1.5 To simulate carpeting, 3/4 inch (19 mm) thick felt pads are to be used and are to be located as specified in SA9.1.4.

SA9.2 Normal temperature

SA9.2.1 A heater, when tested under the conditions described in this section, shall not attain a temperature at any point sufficiently high to constitute a risk of fire or to affect injuriously any material employed in the heater, nor show temperature rises at specific points greater than those indicated in Table SA9.1.

SA9.2.2 All values in Table SA9.1 are based on an assumed ambient (room) temperature of 25°C (77°F), but a test may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F).

Table SA9.1
Maximum acceptable temperature rises

Materials and component parts	°C	°F
1. Any point on a surface adjacent to a cord-connected heater (including the surface on which the heater is supported), and a metal surface of a heater at the point of contact with the test surface.	65	117
2. Knobs and handles, or buttons likely to be contacted by the user and the surfaces likely to be contacted by hands or fingers in grasping handles or buttons. ^{a,b}		
a. Metal surface	35	63
b. Nonmetallic surface ^c	60	108
3. All exposed exterior surfaces of heaters, excluding the grille and its immediate surrounding surface, ^d that are not defined by item 2. ^{b,e}	60	108
<p>^a Points likely to be contacted by a hand or fingers include those points on the gripping surface and adjacent surfaces close enough to be touched while supporting the heater in the intended manner. The length of a normal gripping surface is to be considered 4 inches (102 mm). Points on a surface are not to be considered likely to be contacted if protected by a barrier not less than 5/8 inch (15.9 mm) wide on which the temperature rise does not exceed the value indicated in item 3 or if a through-air spacing of not less than 1-1/2 inches (38 mm) is provided from the gripping surface to the hot part.</p> <p>^b For movable heaters that are shipped with the legs detached, these temperature limitations are applicable only when the heater is operated with the legs in place.</p> <p>^c A knob, handle, or button made of nonmetallic material that is plated or clad with metal having a thickness of 0.005 inch (0.13 mm) or less is considered to be and is judged as a nonmetallic part.</p> <p>^d The grille and its immediate surrounding surface is that part of the enclosure with openings through which heated air passes and the surrounding area within 1 inch (25 mm) over surface of the outer boundary of the grille. The temperature limit does not apply to this area as defined by application of the disc gauge described in note ^e.</p> <p>^e Exposed exterior surfaces are to be defined as the surfaces making contact with a circular disc gauge 8 inches (203 mm) in diameter and 1/16 inch (1.6 mm) thick when the gauge is rolled around the contour of the heater, perpendicular to the horizontal axis of the heater. This determination is to be made with the heater unmounted, but is to exclude those surfaces in contact with the intended mounting surfaces of the heater.</p>		

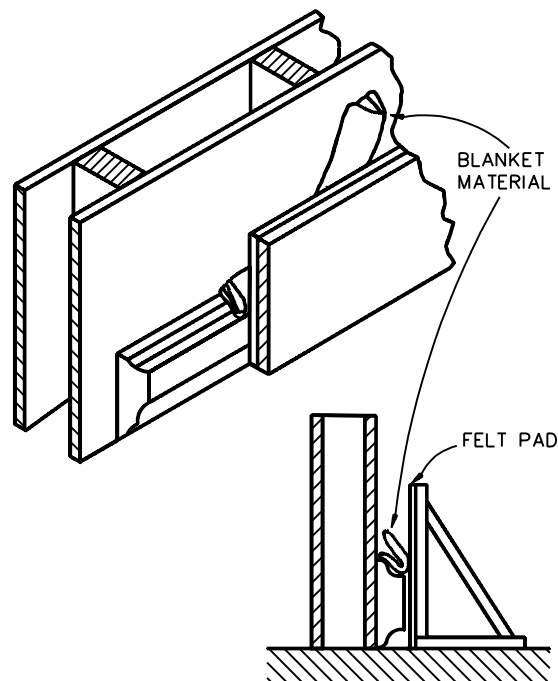
SA10 Padded Surface and Blanketing Test

SA10.1 When tested in accordance with SA10.2 and SA10.3, a heater shall not cause the cheesecloth, felt, blanket material, or wood to glow or flame.

SA10.2 A wood surface covered with a 1 inch (25.4 mm) thick felt pad, and with the pad, in turn, covered with a double layer of cheesecloth, is to be supported in a vertical position as near the heater as the construction of the latter permits. The heater sections are to be covered to such an extent as to produce maximum heating of the cheesecloth, and the padded surface is to extend at least 3 inches (76 mm) above the top surface of the heater. During the test, the covered wood surface is to be moved horizontally 1/2 inch (12.7 mm) away from its initial position to determine the effect of further ventilation. The wood surface is to be sufficiently rigid construction so that it does not change shape (bow or warp) during the test.

SA10.3 While still operating as described in SA10.2 with the padded vertical surface in its initial position in front of the heater, four thicknesses of loosely folded cotton blanket material are to be introduced into the space between the vertical padded surface and the vertical wall on which the heater is mounted so that the upper slot of the heater is blocked. To produce the most adverse operating condition, the folded blanket material is to be located so that any sensing device provided is exposed. A length of folded material up to a maximum of 80 inches (2.03 m) is to be used, but a shorter length of the material may be introduced into space at any one time to obtain the most adverse operating conditions possible. Operation in any one blocked condition is to be continued until constant temperatures are obtained, or until glowing or flaming of the cotton blanket, material results. A typical test setup is shown in Figure SA10.1.

Figure SA10.1
Padded surface and blanketing test



SA11 Curtain Drape Test

SA11.1 When tested in accordance with SA11.2, a heater shall not cause a curtain draped in front of it to glow or flame.

SA11.2 The upper edge of a simulated curtain at least 3 feet (0.9 m) high, but long enough to be supported at least 1 foot (305 mm) above the heater in any case, is to be continuously attached to the wall at the base of which the heater is installed. The curtain is to consist of white duck as specified in SA9.1.5 and an overlay of a double layer of cheesecloth on the side facing the heater, and is to be hung so that the lower edge just touches the floor. During the test, the entire length of the heater is to be initially covered and the curtain is to be arranged to conform as closely as possible with the contour of the heater. Those sections judged to be least likely to affect the operation of the limit control are to be covered. This test shall then be repeated with first:

- a) 3/4 of the heater covered, then with
- b) 1/2 of the heater covered, and then with
- c) 1/4 of the heater covered.

Each test shall be conducted with the heater at room ambient at the start of the test.

SA12 Shredded Paper Test

SA12.1 If the guard described in SA2.2.1 is not provided, there shall be no glowing or flaming of dry, shredded newspaper while a heater is in operation under otherwise intended conditions. The newspaper is to be introduced in any quantity and position in the open slots to attain the most adverse operating conditions.

MANUFACTURING AND PRODUCTION TESTS

SA13 General

SA13.1 Each heater shall be subjected to the tests indicated in SA13.2 – SA13.8.

SA13.2 The current (or power) input to each heater when connected to rated voltage shall not be more than 105 percent of the rated current (or power).

SA13.3 The input may be determined by direct measurement of current (or power), or it may be determined indirectly by measurements of resistance and appropriate computation.

SA13.4 Each heater shall withstand without breakdown the test potential specified in SA13.5, applied between live parts and dead metal parts.

SA13.5 The test potential is to be applied for 1 minute and is to be 1000 volts if the heater is rated at 250 volts or less and is to be 1000 volts plus twice rated voltage if the heater is rated at more than 250 volts; except that the duration may be reduced to 1 second if the value of the test potential is 120 percent of that specified above.

SA13.6 Periodically, two samples of the heater shall be tested for compliance with SA13.2 using instruments that comply with the following:

- a) The accuracy is to be 1 percent of full-scale value or better.
- b) The instrument is to have a full-scale deflection not more than 3-1/3 times the value to be measured.
- c) The smallest scale division of the instrument is to be in accordance with Table SA13.1.
- d) The instrument is to be calibrated at least once per year by comparison with a Standard that is traceable to the National Institute of Standards and Technology.

Table SA13.1
Instrument scale division

Ammeters	
Full scale deflection, amperes	Smallest scale division not more than ___ amperes
1	0.02
5	0.1
10	0.2
more than 10	0.5
Voltmeters	
Full scale deflection, volts	Smallest scale division not more than ___ volts
150	1.5
300	3.0
more than 300	5.0

SA13.7 The manufacturer shall test each heater provided with a power-supply cord incorporating a grounding conductor to determine that electrical continuity exists between an exposed dead metal part of the heater and the grounding blade of the attachment plug.

SA13.8 For the test mentioned in SA13.7, the manufacturer is to employ an indicating device such as an ohmmeter or a low-voltage battery-and-buzzer combination.

MARKING

SA14 Details

SA14.1 Each heater shall be marked in accordance with the following:

a) A permanent marking on the heater where it is readily visible from the exterior of the heater (see SA17.2) after the heater is positioned as intended. The marking shall include the word "WARNING " and the following or equivalent wording— "Risk of fire, keep electrical cords, draping, and other furnishings at least 3 feet (0.9 m) from the front of the heater and away from the side and rear." The marking shall be letters not less than 1/8 inch (3.2 mm) in height and shall be of a permanent type and a color that contrasts with that of the enclosure and background.

b) A tag in accordance with 64.13 and 64.14.

SA14.2 "Readily visible" in SA14.1(a), means visible from a point 5 feet (1.5 m) above the floor and between 1 and 4 feet (0.3 and 1.2 m) away from the front surface of the heater.

SUPPLEMENT SB - HEATERS INTENDED FOR USE IN BATHROOMS, LAUNDRY AREAS AND SIMILAR INDOOR LOCATIONS

INTRODUCTION

SB1 Scope

SB1.1 These requirements cover movable electric heaters intended for use in bathrooms, laundry areas and similar indoor locations. These requirements add to the applicable requirements in the body of this Standard.

SB1.2 The determination of whether this supplement applies to a particular heater shall include a review of the product packaging, instruction manuals, stuffer sheets or other literature packaged with the product.

CONSTRUCTION

SB2 Enclosure

SB2.1 There shall be no wetting of uninsulated live parts when tested as outlined in SB10.1 – SB12.3. The attachment plug of the power supply cord is excluded from this requirement.

Exception No. 1: Heaters incorporating integral IDCI protection need not comply with this requirement.

Exception No. 2: Heaters incorporating integral GFCI protection need not comply with this requirement.

Exception No. 3: Heaters incorporating an integral protective device designed to de-energize all current carrying parts within the heater except the power supply cord when the heater is tested as outlined in SB10.1 – SB12.3.

SB2.2 If water enters the heater enclosure during the tests described in SB10.1 – SB12.3, the water shall drain from the heater without collecting when the heater is repositioned to the normal operating position.

SB3 Current-Carrying Parts

SB3.1 A heater shall not employ current-carrying parts of dissimilar metals that, when used in combination with each other, may deteriorate or corrode due to galvanic action.

Exception: A connection of current-carrying parts that is within a hermetically sealed enclosure is not considered to be exposed to moisture.

SB4 Thermal Insulation

SB4.1 Thermal insulation used in a heater shall not contact uninsulated live parts of that heater.

SB5 Immersion Detection Circuit Interrupters (IDCI'S)

SB5.1 If a heater is provided with a resettable IDCI, the IDCI shall include a supervisory circuit that provides for testing of the ability of the IDCI to interrupt all power to the heater. The supervisory circuit shall be such that the entire sensor circuit (including sensor conductors within the heater enclosure and the sensor conductors in an interconnecting cord between the heater and the IDCI) and the IDCI would be tested. The supervisory circuit shall be suitable for a minimum 6000 cycles of operation.

Exception: If actuation of the supervisory circuit is intended to occur when the heater is moved, shaken or otherwise manipulated in a deliberate manner, the supervisory circuit shall be suitable for a minimum 30,000 cycles of operation.

SB5.2 Parallel connection of individual sections of the sensor circuit may be provided if each connection is mechanically secure and provides reliable electrical contact. Lock washers or other equivalent means to prevent loosening are required if wire-binding screws and nuts are used. Soldered connections are not acceptable.

SB5.3 With respect to SB5.1, operation of the supervisory circuit shall not require the use of a tool.

SB5.4 The results of the test required in SB5.1 shall be indicated by means of an audible, visible, or audible and visible signal.

SB5.5 A resettable IDCI shall be trip-free such that automatic tripping is independent of the manipulation or position of the reset button, handle, lever, or the like of the IDCI.

SB5.6 The sensor conductor within the heater shall be considered an uninsulated live part, and electrical spacings from it to uninsulated live parts of opposite polarity and to accessible dead metal parts shall be maintained as specified in 34.1.

SB5.7 The interconnecting cord between an IDCI and the heater enclosure shall comply with Table 16.1.

Exception: The size of the conductor used as the sensor conductor may be smaller than 18 AWG, but no smaller than 24 AWG.

SB5.8 The material, construction, and location of a sensor shall be such that the intended functioning of the IDCI will not be adversely affected by corrosion, exposure to abnormal operating conditions, and the like as determined in accordance with SB10.1 – SB12.1.

SB5.9 A metal sensor shall not be fabricated of iron or steel.

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

SB6 Ground Fault Circuit Interrupters (GFCI'S)

SB6.1 If a heater is provided with a GFCI, the GFCI shall comply with the requirements for a Class A cord connected GFCI described in the Standard for Ground Fault Circuit Interrupters, UL 943.

SB7 Other Protective Devices

SB7.1 A protective device provided to de-energize current-carrying parts as described in SB10.1 shall be reliable and suitable for the application with respect to its electrical ratings, ambient operating temperature, resistance to electrical transients, resistance to moisture and resistance to mechanical abuse.

SB7.2 If a heater is provided with a resettable protective device, the device shall incorporate a supervisory circuit as described in Section SB5 for IDCI's or in the Standard for Ground Fault Circuit Interrupters, UL 943.

SB8 Switches

SB8.1 A switch included for the testing of a resettable protective device shall be marked "test ", "test switch ", or the equivalent.

SB8.2 A through-cord switch shall not be included.

Exception: A through-cord switch may be employed, provided that it is located no more than 12 inches (30.5 cm) from the end of the power supply cord. The distance shall be measured from the face of the attachment plug to the plane surface of the switch enclosure closest to the heater.

SB9 Grounding

SB9.1 All exposed dead metal parts of a heater that are likely to become energized shall be electrically connected to the equipment grounding conductor of the power supply cord. The articulate probe (Figure 8.3) shall be used to determine accessibility of exposed dead metal parts.

SB9.2 With respect to SB9.1, dead metal parts rendered inaccessible by covers, knobs, buttons and the like secured by friction or snap fit shall be tested as described in SB9.3.

SB9.3 Parts described in SB9.2 shall be subject to a direct pull of 3 pounds (13.34 N) force applied for a period of one minute. The force is to be applied to the points most likely to result in displacement of the part. The part shall not separate from its intended position or render the dead metal parts accessible as determined in SB9.1.

PERFORMANCE

SB10 Immersion Leakage Current Tests

SB10.1 General

SB10.1.1 Heaters shall be subjected to the tests described in SB10.1.4 – SB12.1. The results are acceptable if the leakage current is no more than 5 mA or if a protective device trips, causing the flow of current to ground to cease within the time interval, T, in accordance with the relationship:

$$T = (20/I)^{1.43}$$

when the current to ground, I, is within the range of 6 milliamperes to 264 milliamperes. In the relationship, I is the current to ground in milliamperes rms, and T is the interval in seconds. Unless otherwise specified, leakage current is to be measured throughout the test as described in SB10.1.2 and SB10.1.3 until stabilized conditions are attained.

SB10.1.2 A protective device which de-energizes current carrying parts as described in SB10.1.1 shall not reset automatically.

SB10.1.3 A heater is to be tested while connected to a power supply adjusted to a voltage as determined by Table 39.2. The tests are to be conducted with the heater in various configurations (including the orientation that results in the most unfavorable condition of use) as follows: with the heater switch in the off position, with the heater switch in the on position, and with the heat/fan switches in the most disadvantageous settings. Each test is to be conducted with the supply circuit in one polarity and then with the polarity reversed.

SB10.1.4 Each sample is to be tested in a tank made of nonconductive material and isolated from earth ground. A nominal 0.005 inch (0.13 mm) thick, 1 inch (25.4 mm) wide copper electrode is to be placed in the base of the tank in the vicinity of the heater under test. The length of the electrode on the tank base shall be equal to the largest longitudinal distance on the base of the heater. The overall length of the electrode and its associated wiring is not specified. Unless otherwise specified, the position of the electrode is to be adjusted to yield the highest leakage current and the longest trip time for any protective device that may be provided. Leakage current is to be measured through a 500 ohm resistor shunted by a 0.47 μ F capacitor connected in series with the electrode and the grounded conductor of the power supply. If a protective device is provided to de-energize the heater under the following test conditions, the trip time of the device is also to be measured. These tests shall be conducted two times, with water having a resistivity of 300 ohm-cm and 20,000 ohm-cm.

SB10.2 Rising water immersion

SB10.2.1 A heater is to be placed in the bottom of the tank within 1 inch (25.4 mm) of the copper electrode. Water is to be introduced into the tank through a nonconducting tube at a rate of approximately 17 ounces (0.5 liter) per minute until the heater is completely immersed, begins to float or until an integral protective device of the type described in Section SB5, SB6, or SB7 de-energizes the heater.

SB10.2.2 The test described in SB10.5 is to be conducted using an untested heater with each unit resting on a different external surface for each test. A six-sided heater would be tested using a total of six heaters.

SB10.3 Drop immersion

SB10.3.1 The tank is to be filled with water to a depth equaling the height of the heater plus 1 inch (2.54 cm) with a minimum depth of 12 inches (30.5 cm). The height of the heater is to be determined with the product in its normal intended position and measured from the plane surface on which the heater rests to the plane surface intersecting the uppermost point of the heater enclosure.

SB10.3.2 An untested unit is to be used for each drop immersion. The unit is to be individually dropped from a height of 6 inches (152.4 mm) above the water surface on each external enclosure surface and at other orientations which may yield less advantageous results.

SB10.4 Tip-over immersion test

SB10.4.1 The tank is to be filled with water to a depth of 3/8 inch (0.95 cm). The test is to be performed with an untested heater energized and tipped to its critical angle of balance and permitted to fall over in each possible direction from its normal standing position.

SB10.5 Saturation immersion test

SB10.5.1 This test is to be performed on two previously untested unenergized heaters. Each heater is to be placed in a water reservoir filled with 300 ohm-cm water to a height that completely covers the heater. Following one hour of immersion, the heater is to be removed from the water, dried externally and manipulated to allow water to leave its interior, and then stored for a minimum of 23 hours at $25 \pm 3^{\circ}\text{C}$. The process is to be repeated for a total of 10 cycles. The attachment plug of the heater is not to be immersed for this test.

SB10.5.2 For the test method described in SB10.10, the test unit is to be subjected to a Leakage Current Test following each cycle and a Dielectric Voltage-Withstand Test at the conclusion of the tenth cycle. The Leakage Current Test is to be conducted in accordance with Section 38. The Dielectric Voltage-Withstand

Test is to be conducted in accordance with Section 47, except that the test potential shall be 2500 volts. Electrical contacts of safety devices and mechanical operating members of the devices shall be functional at the conclusion of this test.

SB11 Dew Point Test

SB11.1 Two previously untested heaters are to be conditioned in a cold chamber at $5.0 \pm 2^{\circ}\text{C}$ ($41.0 \pm 3.6^{\circ}\text{F}$) for 4 hours and then transferred immediately into a humidity chamber at 88% $\pm 2\%$ relative humidity at $32 \pm 2^{\circ}\text{C}$ ($89.6 \pm 3.6^{\circ}\text{F}$) for 15 minutes. The transfer time is not to exceed one minute. Immediately after being placed in the humidity chamber, the leakage current is to be measured as described in Leakage Current Test, Section 38, with each heater connected to the intended branch circuit but not operating. At the conclusion of the Leakage Current Test, each heater is to be removed from the humidity chamber and immediately is to be subjected to a Dielectric Voltage-Withstand Test as described in Section 47 except that the test potential is to be 2500 volts.

SB12 Splash Test

SB12.1 A heater is to be mounted as intended on a flat insulating surface for this test. Water with a resistivity of 300 ohms-cm is to be splashed in one motion onto the heater in a manner which is most likely to cause wetting of electrical components. The splashing is to include a direct splash onto any openings in the heater enclosure and an indirect splash where the water first strikes an adjacent surface. Leakage current is to be measured as described in Leakage Current Test, Section 38, except that the resistor is to be 500 ohms and the capacitor 0.47 μF .

SB12.2 The test described in SB12.1 is to be conducted using untested heaters. Three test quantities of water are to be splashed onto the heater: 6 ounces (175 ml), 1 gallon (3.75 liters), and 20 gallons (75.7 liters).

SB12.3 If the heater is intended for wall mounting, the Splash Test is also to be conducted with the heater mounted as intended.

MANUFACTURING AND PRODUCTION TESTS

SB13 Production Line Trip-Time Measurement

SB13.1 The manufacturer shall test each heater which incorporates a resettable protective device provided to comply with the tests described in Sections SB10 – SB12, to determine that the device interrupts power to the heater within 25 ms when the water immersion sensor is contacted by a probe connected to earth ground.

Exception: This test does not apply to heaters incorporating a GFCI or ALCI located in the attachment plug of the power supply cord.

SB14 Test Button Activation

SB14.1 The manufacturer shall test each heater which incorporates a resettable protective device provided to comply with the tests described in Sections SB10 – SB12, to verify that the test circuit is functional.

MARKINGS

SB15 Details

SB15.1 A heater incorporating a resettable protective device, provided to comply with the tests described in Sections SB10 – SB12, shall be marked in accordance with the following:

- a) A permanent marking on the heater or protective device adjacent to the test button indicating "Test".
- b) A permanent type hang tag attached to the flexible cord near the protective device housing. The tag is to include the word "WARNING" a minimum 1/8 inch (3.2 mm) high letters. Following that, the hang tag is to provide instructions regarding the operation of the test button, including identifying its location, and to make reference to the operating instruction manual. It should state "To reduce the risk of electric shock, do not immerse, remove, modify or replace this plug and do not place your heater where it could easily fall into water."

SB15.2 With respect to SB15.1(b), the hang tag shall comply with the Test for Permanence of Cord Tags, Section 53.

SB16 Instructions for Use and Care

SB16.1 The instruction manual is to include instructions regarding the safety test circuit operation and the following statement. "CAUTION: ALTHOUGH THIS DEVICE IS PROVIDED WITH PROTECTION WHICH REDUCES THE RISK OF ELECTRIC SHOCK, THIS PRODUCT SHOULD NEVER BE USED NEAR WATER."

SB16.2 The instruction manual shall not include Part 7 of 65.2.1.

SB16.3 The instruction manual shall not include Part 15 of 65.2.1, but the following or equivalent shall be provided in place of Part 15: "This heater is not intended for use with an extension cord. Plug the cord directly into an appropriate wall receptacle."

SUPPLEMENT SC - MOVABLE ELECTRIC ROOM HEATERS WITH SEMICONDUCTOR HEATING ELEMENTS

INTRODUCTION

SC1 Scope

SC1.1 These requirements cover movable electric room heaters employing semiconductor heating elements having a positive resistance/temperature coefficient (PTC) and self-limiting temperature characteristic. They typically employ electronic fan and/or temperature controllers. These requirements add to the applicable requirements in the body of this Standard.

CONSTRUCTION

SC2 Heating Element

SC2.1 A semiconductor heating element shall comply with the requirements for thermistor-type devices.

Exception: A device employed in a heater which complies with the requirements of the Endurance Test, Section SC12 need not comply with the requirements for the thermistor-type devices..

SC2.2 If the leads or electrode connections to the semiconductor heating element are not an integral part of the element, or are different from those employed during any prior investigation of the element, then the heater shall be subject to the requirements of the Endurance Test, Section SC12.

SC3 Fan Speed Control, Semiconductor Type

SC3.1 A fan speed control that uses semiconductors to regulate the speed of a motor shall comply with the requirements of the Standard for Solid-State Fan Speed Controls, UL 1917. Refer to Section SC9.

SC4 Switches

SC4.1 A switch that directly controls a semiconductor heating element shall have either:

- a) A suitable "T", "L", or "TV" rating, or
- b) A current rating more than six (for alternating-current) or ten (for direct-current) times the rating of the load, or,
- c) A current rating equal to or greater than the values determined when the product is tested in accordance with Input Current Test, Section SC13.

SC4.2 A switch that does not have one of the ratings specified in SC4.1 shall be subjected to the tests described in Overload and Endurance Test, Section SC14. There shall not be any electrical or mechanical malfunction of the switch. At the conclusion of the test, the switch shall be capable of performing its normal function and there shall not be any loosening of parts or any other defect that will appreciably diminish the usefulness and reliability of the switch.

PERFORMANCE

SC5 General

SC5.1 During the Normal Temperature and Abnormal Operations Tests, the room heater shall be energized in accordance with 39.1.9.

Exception: Air heaters which are not marked with a fixed wattage such as "1500 watts" but are marked to reflect a variable maximum input, such as "1500 watt maximum" or "up to 1500 W", shall be tested at the applied voltage value which results in maximum input to the heater, but not less than 95 percent of the marked maximum wattage rating. See 39.1.2 for allowable ambient temperature conditions.

SC6 Input Test

SC6.1 To determine if a heater complies with the requirements of Section 35, the power input is to be measured both with and without any filter, which is provided by the manufacturer and which is removable by the user.

SC7 Normal Temperature Test

SC7.1 Temperatures shall comply with 39.1 when the Normal Temperature Test is conducted in accordance with 39.3 and as noted in SC7.2.

SC7.2 The test is to be conducted with the back of the air heater against the alcove wall. The test is to be conducted both with and without a removable filter in place. If maximum input is not obtained with the air heater in the corner, the test is to be repeated with the heater moved away from the corner by the minimum distance needed to obtain the maximum wattage required by SC5.1. For an air heater that employs adjustable controls for heat or fan speed settings, tests at lower heat and fan speed settings shall also be conducted if the lower settings may produce higher temperatures within the air heater or on the test enclosure. The fan speed shall be recorded for each heat and fan speed setting.

SC8 Low Ambient Temperature Starting Test

SC8.1 When tested in accordance with SC8.2, a fuse placed in series with the heater and power supply shall not open.

SC8.2 In order to determine compliance with SC8.1, three representative air heaters are to be tested. Each heater is to be connected to the power supply through a nontime delay type fuse with a rating equal to that of the attachment plug on the heater supply cord. It is then to be placed in a cold chamber adjusted to produce an air temperature of minus 17.7°C (0°F). The air heater shall be maintained at this temperature until thermal equilibrium. It is then to be energized at rated voltage and observed for operation of the fuse. The test is to be repeated with the heater maintained at a temperature of 0°C (32°F).

SC9 Restricted Inlet, Abnormal Operation Test

SC9.1 The heater shall not show evidence of:

- a) Emission of flame, molten metal, flaming or glowing particles, or flaming drops,
- b) Risk of electric shock (see Accessibility of Live Parts, Sections 8, and Internal Wiring, Section 18), or

- c) Injury to persons (see Protection Against Injury to Persons, Sections 9, and Guarding of Heating Elements, Section 10) when placed on a softwood surface covered by white tissue paper and operated as described in SC9.2.

SC9.2 With the heater operating at rated voltage, the air-inlet opening is to be gradually and uniformly restricted until the opening is completely blocked at the end of 30 minutes or until a temperature limiting control opens the circuit, whichever occurs first. Operation is to continue until temperatures of electrical components, wiring, enclosure surface, and the like, have stabilized.

SC10 DC Offset Voltage Temperature Test

SC10.1 Temperatures shall comply with 39.1 when the DC offset voltage test is conducted in accordance with SC10.2.

SC10.2 A heater having an AC motor that includes or that is intended for use with a solid-state speed control is to be operated under each of the following conditions. The integral appliance speed control shall be bypassed while the offset potential is applied to the motor. The heating element and other electrical components in the heater shall be connected to the supply source and not to the offset voltage supply:

- a) At the speed and, if applicable, the rotation direction resulting in maximum motor temperatures. During this test the heater is to be connected to the load side of a triac. The triac is to be provided with associated circuitry allowing it to be triggered during each half-cycle of the ac input to the heater. Speed control is to be accomplished by varying the trigger points.
- b) Connected and tested as described in (a) with a 2 volt dc offset potential applied to the ac heater input voltage by a suitable method. The 2 volt dc offset potential may be obtained by using a modified speed control having routing diodes and dual triggering circuits to allow independent adjustment of the positive and negative 1/2 cycle triac triggering points. The triggering points are to be adjusted so that a 2 volt dc bias is measured on the switched ac output waveform. The dc bias may be measured by a dc volt meter having a frequency damped response in the range of 0 – 120 hertz.
- c) With the heater connected to an ac supply modified to produce half-wave output. The supply is to be switched from sinusoidal to half-wave output after the heater is operating at its maximum rating. This test is to be conducted in the rotation direction, if reversible, and speed control setting resulting in maximum motor temperatures. If the fan motor shaft will not continue to rotate in a manner considered to be a possible normal condition after the supply is switched from sinusoidal to half-wave operation, the locked-rotor temperature requirements described in SC10.3 shall be used instead of the maximum temperature rises specified in Table 39.1.

SC10.3 If the fan motor shaft does not rotate or rotates in a manner not considered to be normal after the supply is switched from sinusoidal to half-wave operation as described SC10.2(c) or, the motor will not restart when operated from a half-wave source after the motor is de-energized, the motor shall comply with the applicable temperature requirements as follows:

- a) The temperature of an impedance-protected motor shall comply with the Locked-Rotor Temperature Test requirements in the requirements for overheating protection for motors, UL 2111,
- b) The temperature of a thermally-protected motor shall comply with the Locked-Rotor Temperature Test requirements in the Standard for Overheating Protection for Motors, UL 2111, except:

1) For a motor with an automatic reset type protective device, the temperature criteria shall not be applied during the initial cycle of the thermal protector operation and there shall be no emission of flame or molten metal, or

2) For a motor with a nonreplaceable thermal cutoff, the temperature criteria shall not be applied if the thermal cutoff opens within the first hour and there shall be no emission of flame or molten metal.

SC11 Fan Speed Controls, Abnormal Operation Tests

SC11.1 During the applicable tests of the Abnormal Operation Tests, Section 41, there shall be no evidence of:

- a) Emission of flame, molten metal, flaming or glowing particles, or flaming drops,
- b) Risk of electric shock (see Accessibility of Live Parts, Section 8, and Internal Wiring, Section 18), or
- c) Injury to persons (see Protection Against Injury to Persons, Section 9, and Guarding of Heating Elements, Section 10) when an air heater is operated with its discrete electronic components open-circuited and short-circuited, taken one at a time.

Exception: The Abnormal Operation Tests of Section 41 need not be repeated if the component failures introduced into the speed control do not cause fan speed to exceed or be less than the speeds permitted by the control. Refer to SC7.2

SC11.2 A heater employing a fan speed control for which a control component failure could result in a half wave output to a motor, shall be subjected to this test. The heater shall be operated with the half wave output applied to the motor for twelve days for an impedance protected motor, or fifteen days for a thermally protected motor. During the test, the motor temperatures shall not exceed the values specified for the Locked-Rotor Endurance Test for thermally and impedance protected motors in the Standard for Overheating Protection for Motors, UL 2111. The heater shall then be subjected to the Dielectric Voltage Withstand Test of Section 47, after which the motor is to be disassembled and examined for flaking, embrittlement or charring of the winding insulation.

SC12 Endurance Test

SC12.1 An air heater employing a semiconductor heating element having electrode or lead connections not previously investigated is to be subjected to the test specified in SC12.2.

SC12.2 The air heater is to be operated at maximum input as specified in SC5.1 until temperatures stabilize. The air heater is then operated by an external tandem timer control which alternately energizes the air heater and then de-energizes it. The control timer is to be adjusted so that the heating element is energized until it reaches the stabilized temperature previously observed. The air heater is then de-energized until the heating element approaches but is not less than 150°F, at which time the cycle is repeated. A total of 100,000 cycles is to be conducted in this manner. The Normal Temperature Test, Section SC7, is to be repeated under the condition which results in the higher temperature.

SC13 Input Current Test

SC13.1 When required in accordance with SC4.1(c), an air heater employing a switch that directly controls a semiconductor heating element shall be subjected to the test in SC13.2. An alternative test measuring circuit may be employed if it is shown to be equivalent.

SC13.2 The heater is to be connected to a power supply that is switched through a zero voltage cross solid state switch with a series connected reliable fixed resistance. The resistance value is not to exceed 0.1 ohms. The load current is to be measured using a dual channel storage oscilloscope connected across the power supply and the fixed resistance. The complete air heater is then to be placed in a cold chamber adjusted to provide an air temperature of 0°C (32°F). The air heater is to be maintained at this temperature until thermal equilibrium is achieved. It is then to be energized at rated voltage and the voltage across the resistor is to be measured until thermal equilibrium. The test is to be repeated with the heater initially conditioned at a temperature of 20 – 25°C (68– 77°F).

SC13.3 When the tests described in SC13.1 are completed, the input steady state current is to be the calculated RMS value of the steady state voltage measured across the fixed resistance divided by the resistance value after the first 4.2 milliseconds of operation (1/4 cycle). The peak inrush current is to be calculated the same way except that the voltage peak up to and including the first 4.2 milliseconds of operation is to be used. Neither the peak inrush current nor the end steady state current shall exceed the current rating of the switch.

SC14 Overload and Endurance Test

SC14.1 Where required by SC4.2, an overload and endurance test shall be conducted on a switch that directly controls a semiconductor heating element. For these tests, the actual end product load, semiconductor heater and fan motor, is to be used. For testing convenience, the switch may be removed from the end product.

SC14.2 For the overload test, the air heater is to be energized from a supply source adjusted to 125 percent of rated voltage. The switch is to be operated manually by means of its actuating member or by an acceptable mechanical means for 50 cycles of making and breaking the load at a rate of 6 – 10 cycles per minute. For the endurance test the air heater is to be energized from a supply source of rated voltage. The switch is to be operated by means of its actuating member either manually or by an acceptable machine for 6000 cycles of making and breaking the load at a rate of 6 – 10 cycles per minute. The switch shall then be examined to determine compliance with paragraph SC4.2.

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SUPPLEMENT SD - FOLLOW-UP INSPECTION INSTRUCTIONS

Supplement SD deleted June 21, 2000

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SUPPLEMENT SE - DIRECT PLUG-IN HEATERS

INTRODUCTION

SE1 Scope

SE1.1 These requirements cover air heaters that are provided with an integral attachment plug assembly for direct plug-in of the heater to a wall mounted receptacle. These requirements add to the applicable requirements in the body of this Standard.

CONSTRUCTION

SE2 General

SE2.1 A unit shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it is likely to be subjected, without producing or increasing a risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

SE2.2 A unit shall have all parts reliably secured in place.

SE2.3 A unit shall be constructed so that it will not be necessary to open or remove the enclosure when the unit is used as intended.

SE2.4 The maximum acceptable moment, center of gravity, dimensions, and weight of a unit shall comply with the requirements specified in (a) – (d). See SE2.6 :

- a) The quotient of WY/Z shall not exceed 48 ounces (1361 g).
- b) The quotient of WY/S shall not exceed 48 ounces.
- c) The product of WX shall not exceed 80 ounce-inches (0.56 N·m).
- d) The weight of a unit shall not exceed 28 ounces (794 g).

SE2.5 Definitions for the symbols used in SE2.4 are as follows:

W is the weight of the unit in ounces (g).

Y is the distance illustrated in Figure SE2.1 in inches (mm).

Z is the lesser of the two distances, Z_1 or Z_2 , as illustrated in Figure SE2.1 in inches (mm).

S is the lesser of the two distances, S_1 or S_2 , as illustrated in Figure SE2.1 in inches (mm).

X is the greater of the two distances, X_1 or X_2 , as illustrated in Figure SE2.1 in inches (mm).

SE2.6 When inserted in a parallel-blade duplex receptacle, any part of a unit, including a mounting tab or output wiring, shall not interfere with full insertion of an attachment plug into the adjacent receptacle. See Figure SE2.2.

Exception: A unit that renders the adjacent receptacle completely unusable in any one mounting position is acceptable.

SE2.7 A mounting tab shall not be provided with a unit unless all of the following conditions are met:

- a) The unit is intended for use on a 15-ampere, 125-volt receptacle;
- b) A screw is provided and constructed so as to secure the mounting tab of the unit to a parallel-blade duplex receptacle that has a center screw. See Figure SE2.2;
- c) For a unit without a grounding pin, the mounting tab is constructed so that the unit may be mounted to both grounding and nongrounding receptacles.

SE2.8 The moment and weight specified in SE2.4 are to be determined as follows:

- a) For units with directly mounted accessories, the values are to be measured with the accessories in place.
- b) A mounting tab is not to be included in measurements of the linear dimensions for the purpose of determining moments unless:
 - 1) The tab and enclosure withstand the impact described in SE10.1 with one impact on the tab itself, without deformation, and
 - 2) For a polymeric-enclosed unit having an integral tab, the tab and enclosure do not distort at temperatures to which the material may be subjected under conditions of normal and abnormal use as determined by the mold stress-relief distortion test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

SE3 Enclosure

SE3.1 A unit shall be provided with an enclosure that shall house all current-carrying parts other than primary blades. The enclosure shall have the strength and properties necessary to reduce the risk of mechanical damage to the various parts.

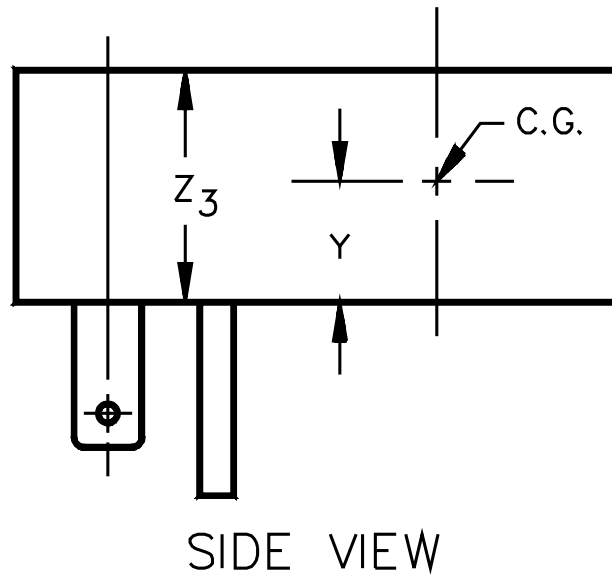
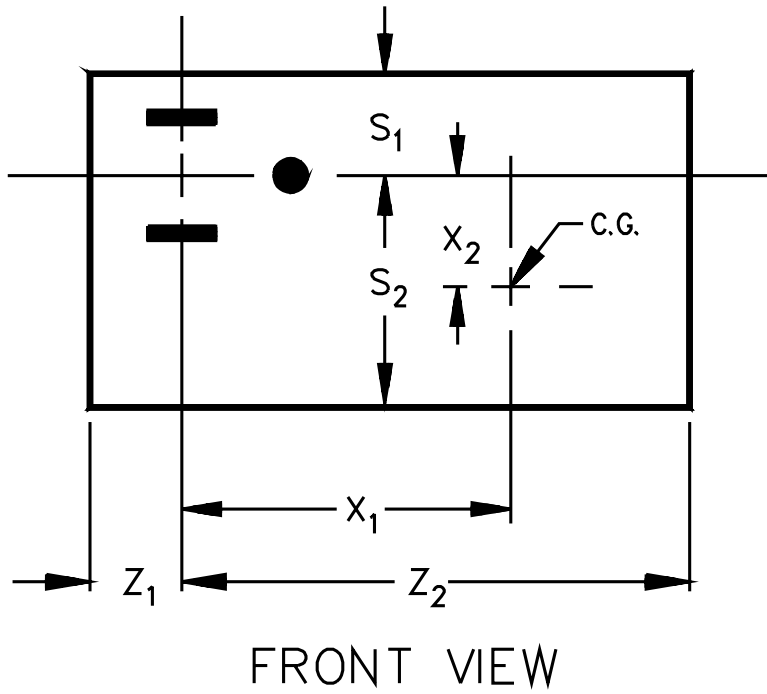
SE3.2 The enclosure of a unit shall be capable of being gripped for removal from the receptacle to which it is connected, and the perimeter of the face section from which the blades project shall not be less than 5/16 inch (7.9 mm) from any point on either blade.

Exception: For tab-mounted units intended for use with fixed systems, the perimeter of the face section may be not less than 1/4 inch (6.4 mm) from any point on either blade.

SE4 Input Connections

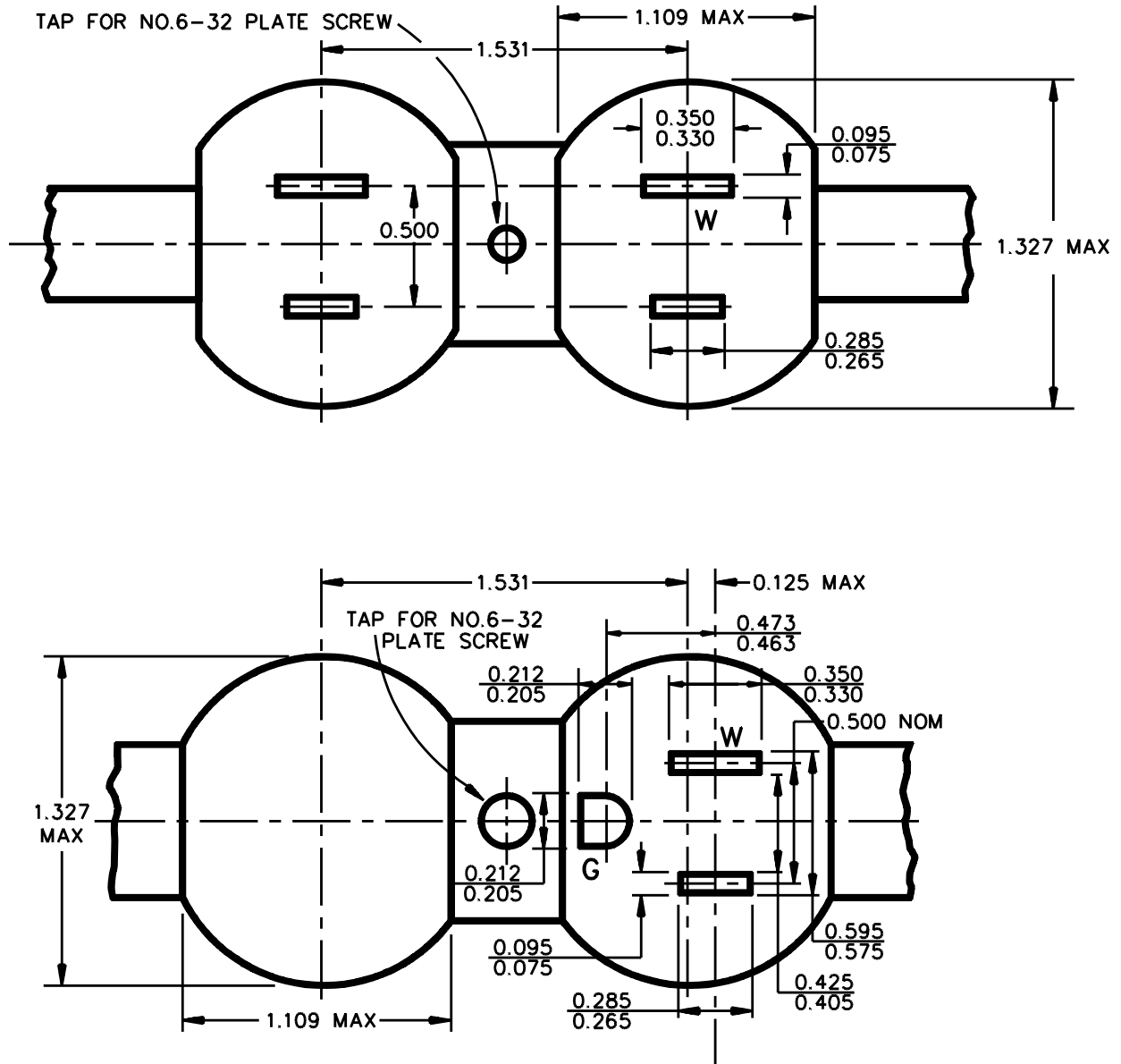
SE4.1 The integral blade assembly shall comply with the construction requirements in the Standard for Attachment Plugs and Receptacles, UL 498.

Figure SE2.1
Dimensions of a direct plug-in heater



C.G. = Center of Gravity

Figure SE2.2
Parallel receptacle duplex



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SE5 Grounding

SE5.1 All dead metal parts that are exposed or that are likely to be touched by a person during intended operation or adjustment of the unit, and that are likely to become energized through electric fault, shall be conductively connected to the grounding member (pin). For units intended for semipermanent installation, a metal mounting tab may serve as the grounding member.

Exception: A metal part, such as an adhesive-attached metal foil marking, a screw, or a rivet separated from wiring and spaced from uninsulated live parts as if it were a grounded part need not be connected to the grounding member.

SE5.2 A grounding pin, if employed on the unit, shall be conductively connected to accessible metal parts. For units not having accessible dead metal parts, the grounding pin shall be connected to:

- a) The core of a transformer or motor and
- b) Other internal dead metal parts.

SE6 Blade Secureness Test

SE6.1 Each blade and the grounding pin, if provided, shall withstand a direct pull of 20 pounds (89 N) for 2 minutes without loosening. The two blades tested together shall also withstand a direct pull of 20 pounds for 2 minutes without loosening. Three samples are to be tested.

SE7 Security of Input Contacts Test

SE7.1 The plug-in blades and the grounding pin shall not loosen to a degree that would introduce a risk of fire or electric shock as a result of the tests described in SE7.2 and SE7.3.

SE7.2 A unit is to be rigidly supported in the blades-up position. Each blade, in turn, is to be individually subjected to a force of 30 pounds (133 N) applied gradually along the longitudinal axis of the blade in a direction towards the face of the unit. The 30-pound force is to be maintained for 1 minute. Three samples are to be tested.

SE7.3 The same samples are to be retested by being positioned as described in SE7.2 and subjecting both blades and the grounding pin, if provided, in combination, to a single applied force of 40 pounds (178 N) for 1 minute.

SE8 Positioning

SE8.1 A direct plug-in heater whose acceptable performance and visibility of controls depends upon its proper location or position shall be marked (such as "Top " or "Bottom ") to indicate the way in which it is to be installed or used and shall have provision for rotation about its plug assembly so that the heater is mounted with its top surface facing up.

SE9 Abuse Tests – General

SE9.1 The enclosure of a unit shall withstand the applicable mechanical abuse tests described in SE10.1 – SE12.1 without:

- a) Making live parts accessible, or
- b) Producing any other condition that would result in a risk of electric shock.

SE10 Abuse Tests – Impact Tests

SE10.1 Three samples are to be subjected to this test. Each unit is to be dropped (free fall) four times in succession from a height of 3 feet (914 mm) onto a concrete floor at least 2-1/2 inches (63.5 mm) thick covered with a nominal 1/8 inch thick vinyl tile. The impact area is to be at least 3 square feet (0.3 m²) in area. Each of the drops is to result in the impact occurring at a point on the unit different from the impact points on the other drops.

SE11 Abuse Tests – Rod Pressure

SE11.1 Any point on the product that is accessible to the rod described in SE11.2 shall be subjected to a force of 20 pounds (89 N) for 1 minute.

SE11.2 The force specified in SE11.1 is to be increased from 0 to 20 pounds (0 to 89 N) over a period of 5 seconds applied through the axis of a 1/2 inch (12.7 mm) diameter metal rod, having a flat contact end with the edge rounded to a radius of 1/32 inch (0.8 mm) to eliminate sharp edges. The force is then to be maintained at 20 pounds for 1 minute. The axis of the rod is to be perpendicular to the surface under test. During the test, the unit is to rest on a flat surface in any convenient position, and is to be energized. Leakage current between the enclosure and ground, and between any parts of the enclosure between which such currents may exist, shall not exceed the limits noted in the Leakage Current Test, Section 38.

SE11.3 Following the rod-pressure test, the unit is to be subjected to the Dielectric Voltage-Withstand Test, Section 47, and to an examination for evidence of the development of a risk of electric shock.

SE12 Abuse Tests – Resistance to Crushing

SE12.1 One sample of the unit shall withstand for 1 minute a steady crushing force of 75 pounds (334 N) applied at right angles to the mounting surfaces. The enclosure is to be tested between two parallel, flat, maple blocks, each not less than 1/2 inch (12.7 mm) thick. One block is to contain slots into which the blades of the device are to be fully inserted. The crushing force is to be applied gradually in a direction normal to the mounting surface.

SE13 Abuse Tests – Switch Retainment

SE13.1 The test in SE13.2 shall not:

- a) Cause damage to the heater's on/off switch or to the receptacle,
- b) Cause the attachment pins of the plug to distort, and
- c) Cause the heater to become dislodged from the receptacle.

SE13.2 The following test shall be conducted on two samples. The maximum force necessary to operate the switch of the heater, F1, is to be determined. With the heater plugged into a receptacle, a force of four times F1 is to be applied to the switch for 1 minute. The test is to be repeated at eight times F1 for 1 minute. The force is to be applied to the free end of the switch, in line with the direction of its intended movement, and it is to be applied in each direction of the movement with the switch set at the extreme position in the direction of movement.

SE14 Abuse Tests – Rotating Plug Assembly Torque Test

SE14.1 The mechanical stop which prevents a rotating type plug from rotating shall not distort or break when the test described in SE14.2 is conducted.

SE14.2 The plug assembly shall be mounted as intended in the heater without any securement screws which are used to prevent rotation of the plug assembly. A lever 1 foot long is to be placed over the blades and secured to the blades by notches cut into the end of the lever. A 15 pound load is to be suspended from the end of the lever for a period of 1 minute in the clockwise direction. The test is to be repeated in a counter clockwise direction.

SE15 Abuse Tests – Static Load-Retainer Plate

SE15.1 The plug retainer plate shall not become dislodged when the following test is conducted: The heater is to be placed on a level surface with the front grille facing down. Any attachment plug securement screws that prevent the plug from rotating are to be removed. A small bucket containing 15 pounds of lead shot is to be applied over the plug face. The test is to be repeated with 25 and 50 pounds.

SE16 Marking

SE16.1 A unit provided with a grounding pin shall be marked with the word "CAUTION " and the following or the equivalent: "To reduce the risk of fire or electric shock connect directly to a grounding receptacle – 3-prong." This marking may be on the unit, a marking tag, or an instruction sheet packed with the unit.

SE16.2 A direct plug-in heater shall be marked with the word "WARNING" and the following or equivalent: "To reduce the risk of fire or electric shock do not use with an extension cord."

SE17 Limitations

SE17.1 A direct plug-in heater shall not be supplied with an extension cord or an extension cord set and shall be provided with the marking specified in SE16.2.

SE18 Abnormal Operation Tests

SE18.1 Even though a direct plug-in heater shall not be used with an extension cord, the heater shall be connected to an extension cord, positioned so the top is up, if constructed according to SE8.1, and tested in accordance with Section 41, Abnormal Operation Tests.

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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

Appliances, Motor-Operated – UL 73
Attachment Plugs and Receptacles – UL 498
Cord Sets and Power-Supply Cords – UL 817
Flexible Cord and Fixture Wire – UL 62
Fuseholders – UL 512
Ground-Fault Circuit-Interrupters – UL 943
Heating Elements, Sheathed – UL 1030
Immersion-Detection Circuit-Interrupters – UL 1664
Limit Controls – UL 353
Motors, Electric – UL 1004
Motors, Overheating Protection – UL 2111
Polymeric Materials – Fabricated Parts – UL 746D
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
Printed-Wiring Boards – UL 796
Switches, Clock-Operated – UL 917
Switches, Special-Use – UL 1054
Tape, Polyvinyl Chloride, Polyethylene, and Rubber-Insulating – UL 510
Temperature-Indicating and -Regulating Equipment – UL 873
Terminal Blocks – UL 1059
Terminals, Electrical Quick-Connect – UL 310
Thermal Cutoffs for Use in Electrical Appliances and Components– UL 1020
Transformers, Specialty – UL 506
Tubing, Extruded Insulating – UL 224
Wire Connectors and Soldering Lugs for Use with Copper Conductors – UL 486A
Wires and Cables, Thermoplastic-Insulated – UL 83
Wires and Cables, Thermoset-Insulated – UL 44

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APPENDIX B**Addendum to the Vertical Wall Test**

As an addendum to this standard, photographs of charred plywood boards are available which show the plywood with the crosschecking as described in 3.3. To order this addendum, write to UL's Standards Department, 333 Pfingsten Road, Northbrook, IL 60062-2096 or call 847-272-8800, extension 42612.

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