UL 875

STANDARD FOR SAFETY

Electric Dry-Bath Heaters

UL Standard for Safety for Electric Dry-Bath Heaters, UL 875

Tenth Edition, Dated July 8, 2024

Summary of Topics

This new Tenth edition of ANSI/UL 875 dated July 8, 2024 includes the following changes from the previous edition:

– Revisions based on the latest version of UL 4200A: Section 9 and 9.1;

– Removal of the reference to UL 6059, Outline for Particular Requirements for Switches for Tools: 26.2;

– Updates to Section 3 to add a list of Referenced Standards and update some references;

– Editorial changes throughout

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated May 3, 2024.

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UL 875

Standard for Electric Dry-Bath Heaters

Prior to the first edition, the requirements for the products covered by this standard were included in the Standard for Electric Heating Appliances, UL 499.

The First through Third editions were titled Electric Dry Bath Heaters. The Fourth Edition was titled Electric Sauna Heating Equipment.

First Edition – August, 1970
Second Edition – February, 1972
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Tenth Edition

July 8, 2024

This ANSI/UL Standard for Safety consists of the Tenth Edition.

The most recent designation of ANSI/UL 875 as an American National Standard (ANSI) occurred on July 8, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in ULSE's Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover electric dry-bath heating equipment and other equipment rated 600 volts or less that is intended to produce a dry-heat environment to be installed in accordance with the National Electrical Code, NFPA 70. The relative humidity in the heated environment is in the region of 10 – 25 % and the purpose of the heated environment (for air temperatures, see Sections 37 and 38) is to promote perspiration in a short time by means of a relatively warm and dry atmosphere. The completed equipment is to be provided with an automatic temperature-regulating control that may be integral with the heater or wall-mounted, with an integral manual-reset limit control, a timer, and any other necessary associated equipment. Electric dry-bath heating equipment and other equipment intended to produce a dry-heat environment may consist of:

a) A heater unit intended for fixed installation in a special room that is built or assembled in the field to comply to the manufacturer's size specifications;

b) A combination of a heater unit and a prefabricated, factory-built rigid room in which the assembled combination may be specified for field installation, or that may be supplied with a power-supply cord and intended to be fastened in place or located in a dedicated space. The room may be arranged so that it can be taken apart for shipment; or

c) A combination of a heater and a rigid cabinet that is constructed to enclose all but the user's head. The unit is provided with a power supply cord and is intended to be fastened in place or located in a dedicated space.

1.2 These requirements do not cover steam-bath heaters, or cable-type radiant-heating equipment, nor any other electric heating equipment or appliances that are covered in separate, individual requirements.

1.3 Throughout these requirements, the term "heater" is used broadly to refer to any heater unit, including its associated control assembly.

1.4 A heater shall employ materials and components throughout that are intended for the particular use and shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

1.5 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 Units of Measurement

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

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

3 Referenced Publications

3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

3.2 The following publications are referenced in this Standard:

ANSI C73.11, *Dimensions of Plugs and Receptacles – General Purpose 125 Volts, 15 Amperes, 2 Poles, 3 Wire Grounding Type*

ANSI C73.12, *Dimensions of Plugs and Receptacles – General Purpose 125 Volts, 20 Amperes, 2 Pole, 3 Wire Grounding Type*

ASTM E28, *Standard Test Methods for Softening Point of Resins Derived from Pine Chemicals and Hydrocarbons, by Ring-and-Ball Apparatus*

ASTM E230/E230M, *Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

IEC 60127-1, *Miniature Fuses – Part 1: Definitions for Miniature Fuses and General Requirements for Miniature Fuse-Links*

IEC 60335-1, *Household and Similar Electrical Appliances – Safety – Part 1: General Requirements*

IEC 60738-1, *Thermistors – Directly heated positive temperature coefficient – Part 1: Generic specification*

IEC 61000-4-2, *Electromagnetic Compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic Discharge Immunity Test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase*

IEC 61000-4-13, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurement techniques – Harmonics and interharmonics including mains signaling at a.c. power port, low frequency immunity tests*

IEC 61558-1, *Safety of transformers, reactors, power supply units and combinations thereof – Part 1: General requirements and tests*

NFPA 70, *National Electrical Code*

UL 20, *General-Use Snap Switches*

UL 44, *Thermoset-Insulated Wires and Cables*

UL 66, *Fixture Wire*

UL 83, *Thermoplastic-Insulated Wires and Cables*

UL 157, *Gaskets and Seals*

UL 224, *Extruded Insulating Tubing*

UL 244A, *Solid-State Controls for Appliances*

UL 248-1, *Low-Voltage Fuses – Part 1: General Requirements*

UL 248-2, *Low-Voltage Fuses – Part 2: Class C Fuses*

UL 248-4, *Low-Voltage Fuses – Part 4: Class CC Fuses*

UL 248-5, *Low-Voltage Fuses – Part 4: Class CC Fuses*

UL 310, *Electrical Quick-Connect Terminals*

UL 353, *Limit Controls*

UL 486A-486B, *Wire Connectors*

UL 486C, *Splicing Wire Connectors*

UL 486E, *Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors*

UL 489, *Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures*

UL 489A, *Circuit Breakers for Use in Communications Equipment*

UL 496, *Lampholders*

UL 499, *Electric Heating Appliances*

UL 507, *Electric Fans*

UL 510, *Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape*

UL 514A, *Metallic Outlet Boxes*

UL 514C, *Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers*

UL 514D, *Cover Plates for Flush-Mounted Wiring Devices*

UL 723, *Test for Surface Burning Characteristics of Building Materials*

UL 746B, *Polymeric Materials – Long Term Property Evaluations*

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

UL 758, *Appliance Wiring Material*

UL 773A, *Nonindustrial Photoelectric Switches for Lighting Control*

UL 796, *Printed Wiring Boards*

UL 817, *Cord Sets and Power-Supply Cords*

UL 840, *Insulation Coordination Including Clearance and Creepage Distances for Electrical Equipment*

UL 873, *Temperature-Indicating and -Regulating Equipment*

UL 917, *Clock-Operated Switches*

UL 935, *Fluorescent-Lamp Ballasts*

UL 943, *Ground-Fault Circuit-Interrupters*

UL 943B, *Appliance Leakage-Current Interrupters*

UL 969, *Marking and Labeling Systems*

UL 1004-1, *Rotating Electrical Machines – General Requirements*

UL 1004-2, *Impedance Protected Motors*

UL 1004-3, *Thermally Protected Motors*

UL 1004-7, *Electronically Protected Motors*

UL 1029, *High-Intensity Discharge Lamp Ballasts*

UL 1030, *Sheathed Heating Elements*

UL 1053, *Ground-Fault Sensing and Relaying Equipment*

UL 1059, *Terminal Blocks*

UL 1097, *Double Insulation Systems for Use in Electrical Equipment*

UL 1411, *Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances*

UL 1434, *Thermistor-Type Devices*

UL 1441, *Coated Electrical Sleeving*

UL 1446, *Systems of Insulating Materials – General*

UL 1557, *Electrically Isolated Semiconductor Devices*

UL 1565, *Positioning Devices*

UL 1577, *Optical Isolators*

UL 1699, *Arc-Fault Circuit-Interrupters*

UL 1977, *Component Connectors for Data, Signal, Control and Power Applications*

UL 2353, *Single- and Multi-Layer Insulated Winding Wire*

UL 2459, *Insulated Multi-Pole Splicing Wire Connectors*

UL 4200A, *Products Incorporating Button Butteries or Coin Cell*

UL 4248-1, *Fuseholders – Part 1: General Requirements*

UL 4248-4, *Fuseholders - Part 4: Class CC*

UL 4248-6, *Fuseholders - Part 6: Class H*

UL 4248-9, *Fuseholders - Part 9: Class K*

UL 5085-1, *Low Voltage Transformers – Part 1: General Requirements*

UL 5085-2, *Low Voltage Transformers – Part 2: General Purpose Transformers*

UL 5085-3, *Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers*

UL 8750, *Light Emitting Diode (LED) Equipment for Use in Lighting Products*

UL 60335-1, *Safety of Household and Similar Electrical Appliances, Part 1: General Requirements*

UL 60384-14, *Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains*

UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*

UL 60730-2-7, *Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Timers and Time Switches*

UL 60730-2-9, *Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Temperature Sensing Controls*

UL 61058-1, *Switches for Appliances –- Part 1: General Requirements*

UL 61800-5-1, *Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy*

U.S. Department of Commerce Voluntary Product Standards PS 1, *Construction and Industrial Plywood*

4 Glossary

4.1 For the purpose of this standard the following definitions apply.

4.2 CONTROL, AUTOMATIC ACTION – A device in which the transmission and operation of at least one function are produced by initiation which is not the result of manual actuation.

4.3 CONTROL, LIMIT – A protective control, see 4.6.

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

4.5 CONTROL, OPERATING – A device where the operation of which starts or regulates the appliance during normal operation. A regulating control is an operating control.

4.6 CONTROL, PROTECTIVE – A device where the operation of which is intended to prevent the risk of electric shock, fire, or injury (including thermal burns and hypothermia) to persons during abnormal operation of the appliance. A limit thermostat is a protective control.

4.7 CONTROL, REGULATING – An operating control, see 4.5.

4.8 CONTROL, SINGLE OPERATION DEVICE – A Type 1.H manual control, see 4.4 and 4.10.

4.9 CONTROL, TYPE 1.D ACTION – The actuation of a manual control designed so that disconnection can neither be prevented nor inhibited, by any reset mechanism and so that after disconnection, it is not possible to re-close the circuit even momentarily while the excess or fault condition persists.

4.10 CONTROL, TYPE 1.H ACTION – The actuation of a manual control that shall be so designed that the contacts cannot be prevented from opening and which may automatically reset to the closed position if the reset means is held in the reset position. The control shall not reset automatically at any temperature above -35 °C (-31 °F) with the reset mechanism in the normal position.

4.11 CONTROL, TYPE 2 ACTION – The actuation of an automatic action control for which the manufacturing deviation and the drift of its operating value, operating time, or operating sequence have been declared and tested under this standard.

4.12 CONTROL, TYPE M2 – A manual control that cannot function as an automatically reset device if the reset means is held in the reset or on position.

4.13 SAFETY CRITICAL FUNCTION (SCF) – Control, protection and monitoring functions which are being relied upon to reduce the risk of fire, electric shock, or casualty hazards.

CONSTRUCTION

5 Component Specifications

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

a) Comply with the requirements for that component as specified in this standard;

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

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

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

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

Exception No. 1: A component of a product covered by this standard is not required to comply with a specific component requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product,

b) Is superseded by a requirement in this standard, or

c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.

Exception No. 2: A component complying with a component standard other than those cited in this standard is acceptable if:

a) The component also complies with the applicable component standard indicated in this standard; or

b) The component standard:

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

2) Considers long-term thermal properties of polymeric insulating materials in accordance with UL 746B, and

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

5.3 A component that is also intended to perform other functions, such as over-current protection, ground-fault circuit-interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable standard(s) that cover devices that provide those functions.

5.4 A component not anticipated by the requirements of this standard, not specifically covered by the component standards of this standard, and that involves a potential risk of electric shock, fire, or personal injury, shall be additionally investigated in accordance with the applicable standard, and shall comply with 5.1 (b) – (d).

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

6 Safety Critical Functions

6.1 Any function involved in the control, protection, and monitoring of safety-related attributes of a unit whereby a loss/malfunction of its functionality would represent an unacceptable risk of fire, electric shock, or casualty hazards would be considered a safety critical function.

6.2 Electronic circuits that manage a safety critical function (SCF) shall be:

a) Reliable as defined as being able to maintain the SCF in the event of single defined component faults; and

b) Not susceptible to electromagnetic environmental stresses encountered in the anticipated environments of the appliance.

6.3 Electronic circuits managing safety critical functions shall comply with:

a) Annex A, Requirements for the Evaluation of Electronic Circuits; or

b) UL 60730-1 and its Part 2's as specified in this standard. The function shall be considered Class B.

6.4 Functions specified in Table 6.1 represent the common safety critical circuit functions of units. It is not intended to represent all possible safety critical functions.

Table 6.1
Safety Critical Functions

Function (see 6.1)	Hazard	Location of parameters and tests
Motor running overload protection	Risk of fire or electric shock	Section 20, Motor-Running Overcurrent Protection
Manual reset temperature limit control, Liquid level controls, Pressure controls	Risk of fire or electric shock	30.1.3
Liquid level controls	Risk of fire or electric shock	Section 31, Liquid Level Controls
Pressure controls	Risk of fire or electric shock	Section 32, Pressure Controls

7 Frame and Enclosure

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

7.2 Among the factors taken into consideration when an enclosure is being evaluated for compliance are its:

a) Physical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Combustibility;

e) Resistance to corrosion;

f) Resistance to distortion at temperatures to which the enclosure may be subjected under conditions of use; and

g) Resistance to ultraviolet light, where applicable.

For a nonmetallic enclosure or part of an enclosure, all these factors are considered with regard to thermal aging.

7.3 A heater shall have provisions for mounting it to the floor, wall, or ceiling. Any fittings, such as brackets, hangers, bolts, or the like, necessary for proper mounting, shall be furnished with the heater together with instructions in accordance with 52.1(d).

7.4 An opening in the bottom of a heater shall not be located below:

a) An electrical part,

b) Wiring, or

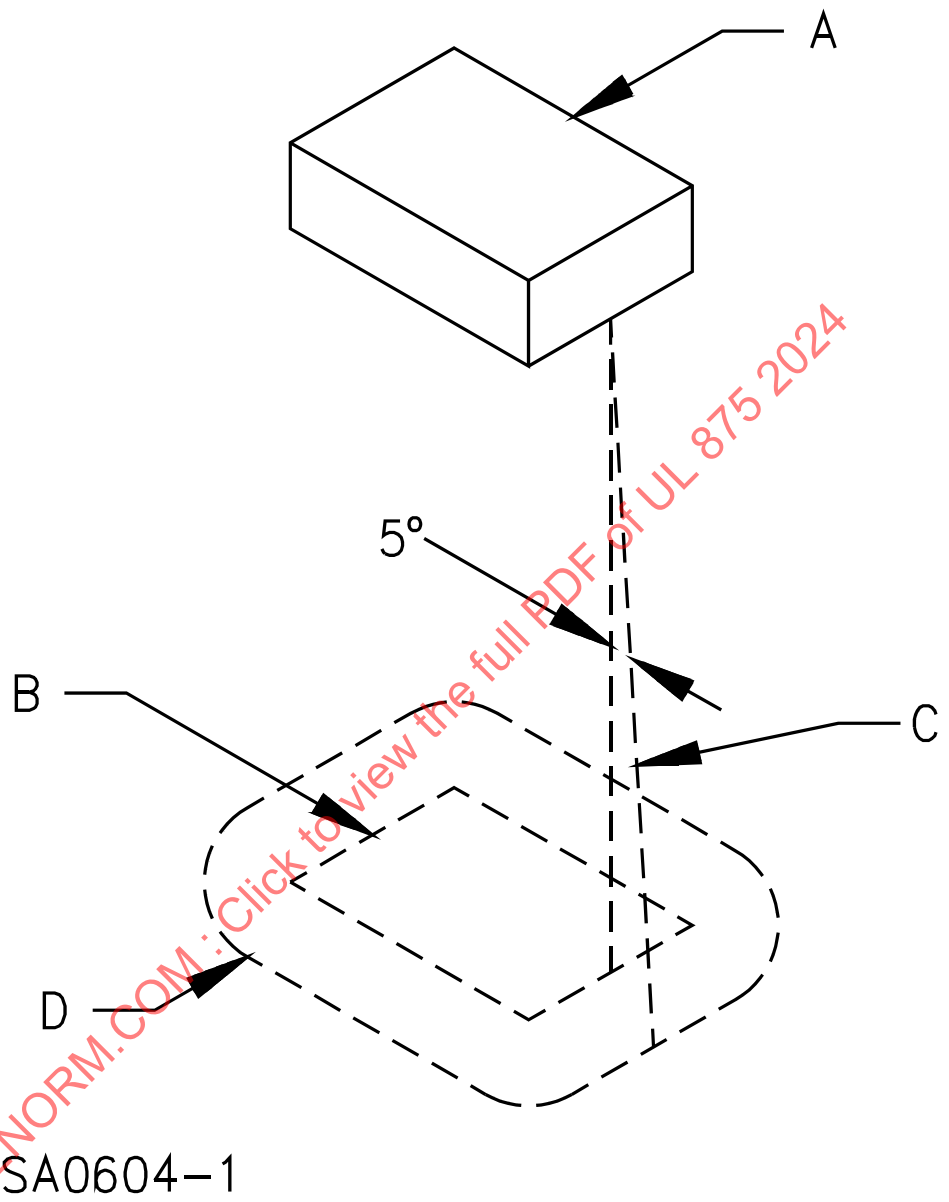
c) A sheath-type heating element

unless a solid, noncombustible protective barrier complying with Figure 7.1 is located between such part, wiring, or element and the supporting surface.

Exception: A barrier is not required under wiring that is provided with insulation having a flame-retardant rating (FR-1).

Figure 7.1

Location and Extent of Barrier



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

B – Projection of outline of component on horizontal plane.

C – Inclined line that traces out minimum area of barrier. When moving, the line is always:

1) Tangent to the component;

2) 5 degrees from the vertical; and

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

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

7.5 The barrier mentioned in 7.4 shall:

a) Be horizontal,

b) Be located as indicated in Figure 7.1, and

c) Not have an area less than that described in the illustration.

Openings provided in the barrier for drainage, ventilation, and similar purposes shall not permit molten metal, burning insulation, or equivalent parts to fall on combustible material or persons (for ceiling-mounted heaters).

7.6 The structure of the part or of the heater may provide the equivalent of the barrier mentioned in 7.4 when it complies with Figure 7.1.

7.7 The requirement in 7.4 requires use of a barrier of noncombustible material:

a) Under a motor unless one of the following four items applies:

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 when the motor is energized under each of the following fault conditions:

i) Main winding opened,

ii) Starting winding opened,

iii) Starting switch short-circuited, and

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

3) The motor is provided with a thermal motor protector (a protective device that is sensitive to both temperature and current) that will restrict 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 complies with the requirements for impedance-protected motors.

b) Under wiring, unless it is of the flame-retardant type. Neoprene-, and thermoplastic-insulated wires have been determined to be of this type.

7.8 The requirement in 7.4 also necessitates that a switch, transformer, relay, solenoid, or the like be completely enclosed, unless it can be shown that malfunction of the component is not likely to result in a fire, or unless there are no openings in the bottom of the heater enclosure. An unbaffled opening in the bottom of the heater enclosure is not to be used when it is located directly below field- or factory-made splices or overcurrent protective devices.

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

7.9 An opening for ventilation provided in the enclosure of a heater or in an externally-mounted component shall be located so that it will not vent into concealed spaces of a room, such as into false-ceiling space, into hollow spaces in the wall, or the like when the heater is installed as intended.

7.10 An opening for ventilation in the enclosure (other than in the bottom) of a heater and an opening associated with the dissipation of heater air from the element shall be provided with one or more baffles that will restrict the emission of flame, molten metal, burning insulation, or the like from the heater.

Exception: In a compartment other than one that houses an overcurrent protective device (such as fuses, circuit breakers, and the like), the baffles are not prohibited from being omitted when:

a) No ventilation 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) wide or

b) The heater is constructed so that it complies with the intent of these requirements, as shown by investigation.

7.11 The minimum thickness of cast- and sheet-metal portions of the enclosure shall be as indicated in Table 7.1.

Table 7.1
Minimum Thicknesses of Enclosure Metal

Metal	At small, flat unreinforced surfaces and at surfaces that are reinforced by curving, ribbing, and similar reinforcement (or are otherwise of a shape or size) to ensure adequate physical strength		At relatively large, flat unreinforced surfaces	
	mm	(inch)	mm	(inch)
Die-cast	1.2	(3/64)	2.0	(5/64)
Cast malleable iron	1.6	(1/16)	2.4	(3/32)
Other cast	2.4	(3/32)	3.2	(1/8)
Uncoated sheet steel	0.66[a]	(0.026)[a]	–	–
Galvanized sheet steel	0.74[a]	(0.029)[a]	–	–
Nonferrous sheet	0.91[a]	(0.036)[a]	–	–

[a] Thinner sheet metal is not prohibited from being used when determined to be equivalent after evaluation under considerations such as those mentioned in 7.2 and 7.12.

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

7.13 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than:

a) 0.81 mm (0.032 inch) for uncoated steel;

b) 0.86 mm (0.034 inch) for galvanized steel; and

c) 1.14 mm (0.045 inch) when nonferrous.

7.14 A tapped hole for the attachment of threaded rigid conduit shall be provided with:

a) An end stop, or shall be located so that a standard bushing may be attached to the end of conduit and

b) At least three full threads when tapped all the way through the wall of an enclosure, or with at least 3-1/2 full threads and a smooth, well-rounded inlet hole having a diameter approximately the same as the internal diameter of a standard bushing to provide resistance for the conductors equivalent to that provided by such a bushing.

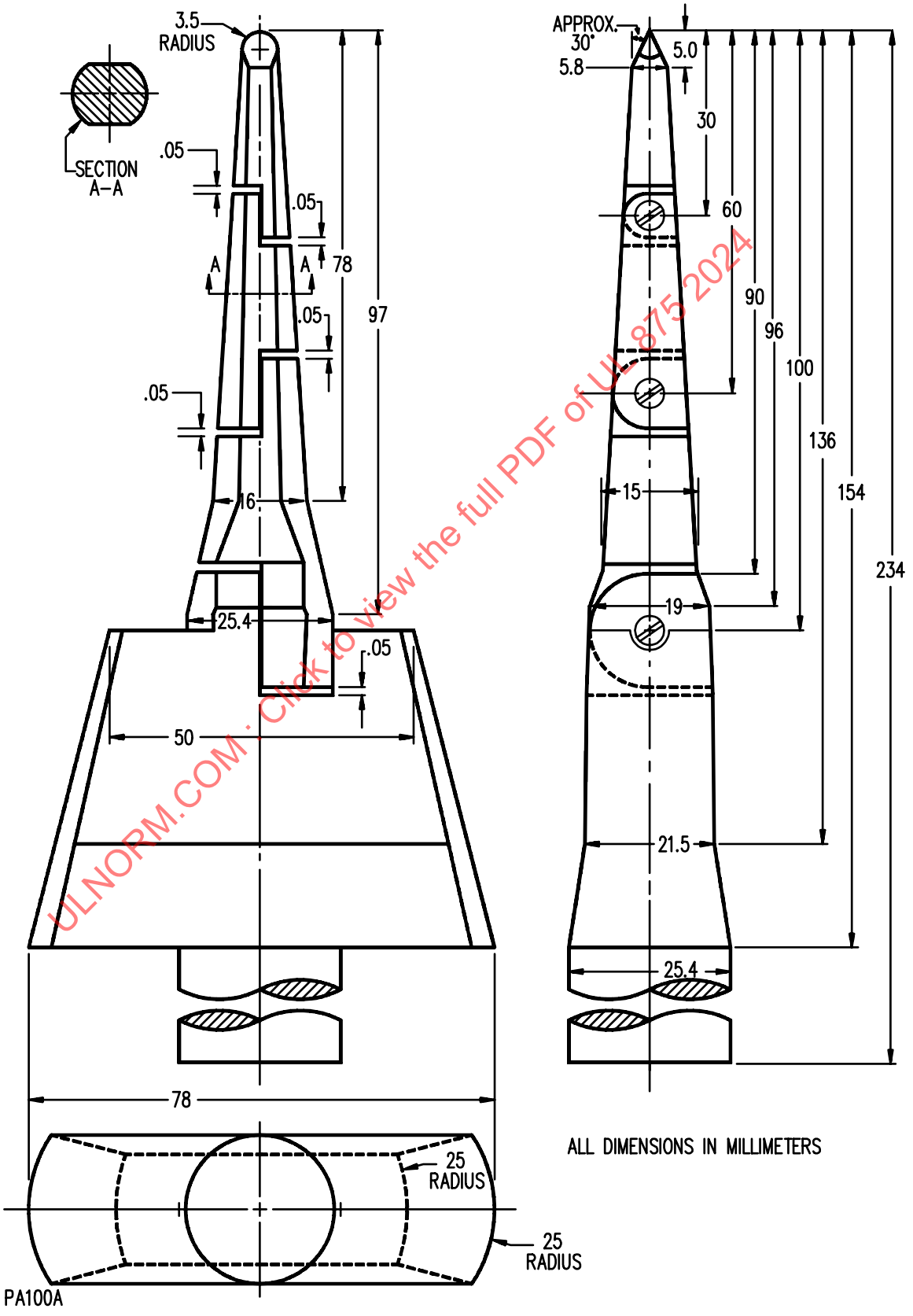
7.15 An electrical part of a heater shall be located or enclosed so that resistance to unintentional contact with live parts will be provided.

7.16 In determining when an opening in an enclosure is to be used, consideration is to be given to the proximity of live parts and the possibility of the emission of burning insulation, molten metal, and the like through the opening.

7.17 The probe illustrated in Figure 7.2 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 try to contact an uninsulated live part or film-coated wire. The probe shall be applied in the above-described manner and in any possible configuration; and, when necessary, the configuration shall be changed after insertion through the opening. Configuration refers to positioning of the jointed portions of the probe.

Figure 7.2

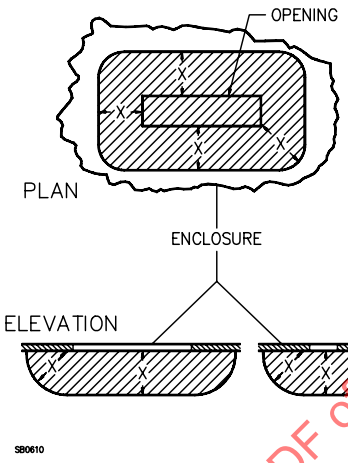
Articulate Probe with Web Stop



7.18 An opening that will permit entrance of a 3/4-inch diameter rod may be used under the conditions described in connection with Figure 7.3.

Figure 7.3

Opening in Enclosure



(Proportions exaggerated for clarity)

NOTE – The opening may be used if, within the enclosure, there is no uninsulated live part or enamel-insulated wire less than X distance from the perimeter of the opening, as well as within the volume generated by projecting the perimeter X distance normal to its plane. X equals five times the diameter of the largest diameter rod which can be inserted through the opening, but not less than 101.6 mm (4 inches). In evaluating an opening, any barrier located within the volume usually is ignored unless it intersects the boundaries of the volume in a continuous, closed line.

7.19 During the examination of a heater in connection with the requirements in 7.15 – 7.17, a part of the outer enclosure that may be removed without the use of tools (to permit the attachment of accessories, to allow access to means for making operating adjustments, or for other reasons) is to be disregarded. It will not be assumed that such a part affords resistance to electric shock. A warning marking as specified in 50.10 is not considered to eliminate the risk of electric shock.

7.20 Gaskets and seals that comply with UL 157, are considered to fulfill the requirements of 14.2.

7.21 Unless otherwise specified in this end product standard, polymeric electrical insulating materials and enclosures shall comply with the applicable requirements of UL 746C.

7.22 Metallized or painted polymeric parts or enclosures shall comply with the applicable requirements of UL 746C. This requirement is not applicable to exterior surfaces of polymeric enclosure materials or parts provided that the metallized coating or paint does not offer a continuous path for an internal flame to propagate externally.

8 Risk of Injury to Persons

8.1 The rotors of motors, pulleys, belts, gears, and the like shall be enclosed or guarded to reduce adequately the risk of injury to persons.

8.2 With reference to the requirement in 8.1, the degree of protection required of the enclosure depends upon the general design and intended use of the heater. Among the factors to be taken into consideration in evaluating the compliance of the exposed moving parts are:

a) The degree of exposure;

b) The sharpness of the moving parts;

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

d) The speed of movement of those parts; and

e) The risk of fingers, arms, or clothing being drawn into the moving parts.

8.3 The location of the heater will be taken into consideration in evaluating the intended degree of exposure of mechanical and electrical parts. For example, a greater degree of exposure may be used in a ceiling-mounted heater.

8.4 An edge, projection, or corner of an enclosure, opening, frame, guard, knob, handle, or the like of a heater shall be smooth and rounded, and not sharp enough to cause a cut-type injury when contacted during intended use or user maintenance.

8.5 When the external surface of the heater is of metal and exceeds 70 °C (158 °F) during intended operation or is of nonmetallic material and exceeds 95 °C (203 °F) during intended operation, the heater shall be provided with a nonmetallic guard or fence to restrict unintentional physical contact with the heater.

Exception: When the room is not provided as part of the heater, the installation instructions required in 52.1(h) shall state the type of fence or guard to be installed.

8.6 The construction of a wall- or ceiling-mounted heater and its mounting hardware shall be subjected to the Static Loading Test, Section 45.

8.7 The construction and supporting hardware of a floor-mounted heater shall be subjected to the Static Loading Test, Section 45, and the Strength of Legs Test, Section 46.

9 Button Batteries or Coin Cell Batteries

9.1 The battery compartment of an appliance or any accessory, such as a wireless control, incorporating one or more button batteries or coin cell batteries shall comply with UL 4200A, if the appliance or any accessory:

a) Is intended for use with one or more single cell batteries having a diameter of 32 mm (1.25 in) maximum with a diameter greater than its height; and

b) The appliance is intended for consumer use.

10 Assembly

10.1 The door or cover of an enclosure shall be hinged when:

a) It gives access to any fuse, circuit breaker, or manually-resettable thermal cutoff and

b) Uninsulated current-carrying parts are exposed in connection with the intended replacement of the fuse or resetting of a manually-resettable device.

Such a door or cover also shall be provided with a latch or the equivalent and a captive screw to secure the door or cover in place.

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

10.3 A spring latch, magnetic latch, 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, may be used as a means for holding the door in place as required in 10.2.

10.4 A component of a heater that is likely to need inspection, replacement, cleaning, or other servicing shall be as readily accessible as practicable, without the use of special tools (flat blade and Phillips screwdrivers are not considered special tools) when it is intended to be manually operated or adjusted or when it will require periodic servicing.

10.5 A switch, lampholder, motor-attachment plug, or similar component shall be mounted securely and restricted from turning.

Exception No. 1: The requirement that a switch be restricted from turning may be waived when the following four conditions exist:

a) Means of mounting the switch make it unlikely that operation of the switch will loosen it;

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

c) The spacings are not reduced below the minimum required values when the switch rotates; and

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

Exception No. 2: 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 a nonremovable jewel) need not be restricted from turning when rotation cannot reduce spacings below the minimum required values.

10.6 The means for restricting the turning mentioned in 10.5 and 10.7 is to consist of more than friction between surfaces – for example, a lock washer, applied as intended, may be used as means to restrict turning of a small stem-mounted switch or other device having a single-hole mounting means.

10.7 A current-carrying part shall be secured to the base or mounting surface so that it will be restricted from turning or shifting in position when such motion may result in a reduction of spacings below the minimum values indicated in Spacings, Section 33.

11 Corrosion Resistance

11.1 Iron and steel parts shall be made resistant to corrosion by enameling, galvanizing, plating, or other equivalent means when the breakdown of such unprotected parts would be likely to result in the risk of fire, electric shock, or injury to persons.

Exception: Under certain conditions in which the oxidation of steel is not likely to be accelerated due to the exposure of metal to air, 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 made resistant to corrosion. Cast-iron parts are not required to be made resistant to corrosion. A sheath used on a heating element operating in air and terminal parts attached directly to the heating element need not be made resistant to corrosion.

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

12 Supply Connections

12.1 General

12.1.1 A heater shall have provision for connection of one of the wiring systems in accordance with NFPA 70.

12.2 Field-wiring compartment

12.2.1 The location of a wiring compartment in which field-wiring connections are to be made shall be such that these connections may be readily inspected without moving the heater after it is installed as intended.

12.2.2 When a separate wiring compartment is provided for field-wiring connections, it shall be attached to the heater and restricted from turning with regard to the heater.

12.2.3 A wiring compartment for field-wiring connections shall be of metal and shall have a volume that will accommodate the wiring of the size indicated in 12.4.1 and conduit and fittings sized for that wire.

12.2.4 Electrical boxes and the associated bushings and fittings, and raceways, of the types specified in Chapter 3 of NFPA 70 and that comply with the relevant UL standard (such as UL 514A, UL 514C, UL 514D) and 5.1 are considered to fulfill the requirements of this standard.

12.3 Wire-bending space

12.3.1 The wire-bending space from a connector to the wall of an enclosure and to any barrier or other obstruction that is part of the equipment shall be as specified in Column A of Table 12.1. The width of a wiring gutter provided at a knockout shall not be less than specified in Column A of Table 12.1.

Table 12.1
Wire-Bending Space

Wire size		Minimum bending space, terminal to wall			
		A[a]		B[b]	
mm^2	(AWG)	mm	(inches)	mm	(inches)
2.1 – 5.3	(14 – 10)	Not specified		Not specified	
8.4	(8)	38.1	(1-1/2)	38.1	(1-1/2)
13.3	(6)	38.1	(1-1/2)	50.8	(2)
21.2	(4)	50.8	(2)	76.2	(3)
26.7	(3)	50.8	(2)	76.2	(3)
33.6	(2)	63.5	(2-1/2)	88.9	(3-1/2)
42.4	(1)	76.2	(3)	114.3	(4-1/2)
53.5	(1/0)	88.9	(3-1/2)	139.7	(5-1/2)
67.4	(2/0)	88.9	(3-1/2)	152.4	(6)

Table 12.1 Continued on Next Page

Table 12.1 Continued

Wire size		Minimum bending space, terminal to wall			
		A[a]		B[b]	
mm^2	(AWG)	mm	(inches)	mm	(inches)
NOTE – The minimum bending space required for wire sizes or combinations not covered in this table will be determined by investigation.					
[a] See 12.3.1 for construction applications of the wire-bending space.					
[b] See 12.3.2 for construction applications of the wire-bending space.					

12.3.2 When a hole, knockout, or other provision for connection of a wiring system is provided in the wall opposite the terminal, it is to be assumed that a conductor will enter or exit the enclosure through that wall; in this case, the wire-bending space shall be as specified in Column B of Table 12.1.

12.3.3 When a conductor is restricted from being bent where it leaves the connector by a barrier or other means, the distance shall be measured from the end of the barrier or other obstruction.

12.3.4 The distance mentioned in 12.3.2 is to be measured in a straight line from the edge of the wire terminal closest to the wall in a direction perpendicular to the enclosure wall or barrier. The wire terminal is to be turned to all positions it can assume without defeating any means provided to prevent its turning, such as a box or shoulder, the walls of a recess, or multiple bolts securing the connector.

Exception: Wire-bending space may be measured in a straight line from the center of the wire opening in the direction the wire leaves the terminal. However, it is to be assumed that the connector is not oriented so the wire will be directed into a corner of the enclosure to such an extent that the location of the transverse wall would necessitate additional bending. When the connectors for a circuit are fixed in position – for example, by the walls of a recess – so they are turned toward each other, the distance is to be measured at the wire opening nearest to the wall, in a direction perpendicular to the wall.

12.4 Field-wiring terminals and leads

12.4.1 A heater shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity not less than 125 % of the current rating of the heater.

12.4.2 No electrical component shall be mounted on a part intended for use as a cover plate that must be removed for examination of field-wiring connections.

12.4.3 A lead intended for connection to a power supply conductor shall have a minimum 90 °C (194 °F) temperature rating.

12.4.4 In determining the size of the power-supply conductors in a heater intended for connection to multiple power supplies and in which it is likely that more than three such conductors will occupy the same raceway, the ampacity deratings given in the NFPA 70, are to be applied.

12.4.5 For the purpose of these requirements, field-wiring terminals are terminals to which power-supply or control connections will be made in the field when the heater is installed. When field-supplied wiring is taken into the room or walls, it is assumed that minimum 90 °C (194 °F) wire is to be used for connection of field-wiring terminals in accordance with 50.13.

12.4.6 A sheet-metal screw shall not be used as a wiring terminal or for securing a wiring terminal such as a pressure-wire connector.

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

Exception: A wire-binding screw may be used at a field-wiring terminal intended to accommodate a 5.3 mm^2 (10 AWG) or smaller conductor when upturned lugs or the equivalent are provided to hold the wire in position.

12.4.8 A wire-binding screw at a field-wiring terminal shall not be smaller than 4.8 mm diameter (No. 10).

Exception: A 4.2 mm diameter (No. 8) screw may be used at a terminal intended only for the connection of a 2.1 mm^2 (14 AWG) conductor, and a 3.5 mm diameter (No. 6) screw may be used for the connection of a 1.3 mm^2 (16 AWG) or 0.82 mm^2 (18 AWG) control-circuit conductor.

12.4.9 A terminal plate tapped for a wire-binding screw shall be of metal not less than 1.3 mm (0.050 inch) thick. There shall be two or more full threads in the metal, which may be extruded when necessary to provide the threads.

Exception: A plate not less than 0.8 mm (0.030 inch) thick may be used when the tapped threads have adequate strength.

12.4.10 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned either in 12.4.1 [but not smaller than 2.1 mm^2 (14 AWG)] or in 12.4.14, whichever is applicable, under the head of the screw or the washer.

12.4.11 A heater provided with field-wiring terminals or leads and intended to be connected to a grounded power-supply conductor shall have one terminal or lead identified for the connection of that conductor when necessary because of the requirements in 25.1, 26.4, 26.5, and 30.1.6.

12.4.12 A field-wiring terminal intended for the connection of a grounded conductor shall be made of, or plated with, a metal substantially white in color and shall be readily distinguishable from the other terminals, or proper identification of that terminal shall be clearly shown in some other manner, such as on an attached wiring diagram. A lead intended for the connection of a grounded conductor (as distinguished from the equipment grounding conductor) shall be finished to show a white or gray color and shall be readily distinguishable from the other leads.

Exception: Internal wiring that is not visible in a wiring compartment in which field connections are to be made need not be color coded for identification.

12.4.13 An equipment grounding terminal or lead shall be provided.

12.4.14 A grounding terminal shall be capable of securing a conductor of the intended size.

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

Exception: Internal wiring that is not visible in a wiring compartment in which field-wiring connections are to be made need not be color coded for identification.

12.4.16 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green head that is hexagonal-shaped, slotted, or both. A sheet-metal screw shall not be used for this purpose. A pressure wire connector intended for connection of such a conductor shall be plainly identified, such as by being marked "G," "GR," "GND," "Ground," "Grounding," or the like, or by a suitable

marking on a wiring diagram provided on the heater. The wire-binding screw or pressure wire connector shall be located so that it is unlikely to be removed during servicing of the heater, and the wire-binding screw shall have upturned lugs or the equivalent to retain the conductor.

12.4.17 The free length of the lead for connection to the branch circuit inside an outlet box or wiring compartment shall be 152 mm (6 inches) or more.

Exception: The lead may be less than 152 mm long when the field-wiring supply connections are enclosed in the motor terminal box.

13 Current-Carrying Parts

13.1 Plated iron or steel may be used for current-carrying parts whose temperature during intended operation is more than 100 °C (212 °F), but plain (unplated) iron or steel shall not be used regardless of temperatures. Stainless steel and other corrosion resistant alloys may be used for current-carrying parts regardless of temperature.

13.2 Unplated iron or steel, when provided with a corrosion-resistant coating, may be used for a current-carrying part within a motor or associated governor.

14 Internal Wiring

14.1 General

14.1.1 The internal wiring of a heater shall not be less than 0.82 mm^2 (18 AWG) and shall be standard building wire, fixture wire, or other type rated for the application considering temperatures, voltage, current, and conditions of service to be encountered.

14.1.2 There is no temperature limit applicable to glass fiber, beads of noncarbonizable material, or the equivalent used as conductor insulation.

14.1.3 Internal wiring composed of insulated conductors shall comply with UL 758.

Exception No. 1: Insulated conductors need not comply with UL 758 if they comply with one of the following:

a) UL 44;

b) UL 83;

c) UL 66;

d) the appropriate UL standard(s) for other insulated conductor types specified in Chapter 3 (Wiring Methods and Materials) of NFPA 70; or

e) UL 817.

Exception No. 2: Insulated conductors for specialty applications (e.g. data processing or communications) and located in a low-voltage circuit not involving the risk of fire or personal injury need not comply with UL 758.

14.2 Sleeving and tubing

14.2.1 Coated or impregnated insulating tubing complying with the applicable requirements for such tubing may be used. Where not subjected to moisture in use, uncoated and unimpregnated sleeving of closely-woven glass fiber may be used when it complies with the requirements in Table 14.1.

Table 14.1
Sleeving and Tubing

Maximum inside diameter		Voltage across tubing	Minimum thickness	
mm	(inch)		mm	(inch)
2.16	(0.085)	300 volts or less	0.51	(0.020)
	(12 AWG)	301 – 600 volts	0.64	(0.025)
12.70	(0.50)	600 volts or less	0.64	(0.025)
Larger than 12.70	(Larger than 0.50)	600 volts or less	0.79	(0.031)

14.3 Protection of wiring

14.3.1 The wiring and connections between parts of a heater shall be protected or enclosed.

Exception: A length of flexible cord may be used for internal connections that may be exposed during servicing when flexibility of the wiring is essential.

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

14.3.3 A probe as illustrated in Figure 7.2 shall be restricted from contacting internal wiring that is exposed through an opening in the enclosure of a heater or a control assembly.

Exception: Internal wiring that is capable of being contacted by the probe illustrated in Figure 7.2 shall be secured within the enclosure so that it will not be subjected to stress or mechanical damage.

14.3.4 When the wiring of a heater is located so that it may be in proximity to combustible material or may be subjected to physical damage, it shall be in:

a) Armored cable;

b) Rigid metal conduit;

c) Electrical metallic tubing; or

d) Metal raceway;

or otherwise protected.

14.3.5 Wiring shall be protected from sharp edges (including male screw threads), burrs, fins, moving parts, and other features that might cut or abrade the insulation.

14.3.6 When wiring passing through a metal wall within an overall enclosure of a heater can contact the edge of the opening, the opening shall be provided with:

a) A smooth, turned edge;

b) A metal grommet; or

c) An insulating bushing.

14.3.7 Wire positioning devices shall comply with 14.5 and Section 15. A device that complies with UL 1565, is considered to fulfill this requirement.

14.4 Splices and connections

14.4.1 Each splice and connection shall be mechanically secure and shall provide reliable electrical contact. A soldered connection shall be made mechanically secure before being soldered when breaking or loosening of the connection may result in a risk of fire, electric shock, or injury to persons.

14.4.2 A splice shall be provided with insulation determined to be equivalent to that of the wires involved when permanence of spacing between the splice and other metal parts will not be permanently maintained.

14.4.3 In determining when splice insulation consisting of coated fabric, thermoplastic, or other tubing may be used, 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 to be used. An insulated splicing device may be used within the limits of its voltage and temperature ratings.

14.4.4 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill 14.4.3 or a performance requirement of this standard. In such cases:

a) Insulating tape shall comply with UL 510;

b) Sleeving shall comply with UL 1441;

c) Tubing shall comply with UL 224.

14.4.5 The means of connecting stranded internal wiring to a wire-binding screw shall be such that loose strands of wire will be restricted 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.

14.4.6 An open-end spade lug shall not be used unless means are provided to hold the lug in place when the wire-binding screw or nut becomes slightly loosened. Upturned ends on the tang of the lug or a retaining barrier may be used to hold the lug in place.

14.4.7 Aluminum conductors, insulated or uninsulated, used as internal wiring, such as for interconnection between current-carrying parts, or as motor windings, shall be terminated at each end by a method that has been investigated and determined to be equivalent for use for the combination of metals involved at the connection point.

14.4.8 When a wire-binding screw construction or a pressure-wire connector is used as a terminating device, it shall be rated for use with aluminum under the conditions involved (for example, temperature, heat cycling, vibration).

14.4.9 Quick-connect terminals, both connectors and tabs, for use with one or two 22 – 10 AWG copper conductors, having nominal widths of 2.8, 3.2, 4.8, 5.2, and 6.3 mm (0.110, 0.125, 0.187, 0.205, and 0.250 inch), intended for internal wiring connections in appliances, or for the field termination of conductors to the appliance, shall comply with UL 310.

Exception: Other sizes of quick-connect terminals shall be investigated with respect to crimp pull out, insertion-withdrawal, temperature rise, and all tests shall be conducted in accordance with UL 310.

14.4.10 Single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment, and that are intended for factory assembly to copper or copper alloy conductors, or for factory assembly to printed wiring boards, shall comply with UL 1977. See 14.4.15.

14.4.11 Wire connectors shall comply with UL 486A-486B.

14.4.12 Splicing wire connectors shall comply with UL 486C.

14.4.13 Multi-pole splicing wire connectors that are intended to facilitate the connection of hard-wired utilization equipment to the branch-circuit conductors of buildings shall comply with UL 2459. See 14.4.15.

14.4.14 Equipment wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with UL 486E.

14.4.15 Terminal blocks shall comply with UL 1059, and, if applicable, be suitably rated for field wiring.

Exception: A fabricated part performing the function of a terminal block need not comply with UL 1059 if the part complies with the requirements of Section 13 (current-carrying parts), Section 14 (insulating material), 14.4 (splices and connections), and Section 33 (spacings) of this end product standard. This exception does not apply to protective conductor terminal blocks.

14.4.16 Female devices (e.g. receptacles, appliance couplers, and connectors) that are intended, or that may be used, to interrupt current in the end product, shall be suitably rated for current interruption of the specific type of load, when evaluated with its mating plug or connector. For example, an appliance coupler that can be used to interrupt the current of a motor load shall have a suitable horsepower rating when tested with its mating plug.

14.5 Separation of circuits

14.5.1 Conductors of different circuits used in internal wiring, including insulated wires used in a terminal box or compartment, shall either be:

a) Provided with insulation rated for the highest voltage involved; or

b) Separated by barriers or spacing.

Conductors shall in any case be separated by barriers or spacing from uninsulated current-carrying parts connected to different circuits.

14.5.2 Low-voltage and line-voltage circuits are considered to be different circuits under these requirements.

14.5.3 Spacing of insulated conductors may be accomplished by clamping, routing, or an equivalent means that maintains separation from insulated or uninsulated current-carrying parts of a different circuit.

14.5.4 A barrier shall be provided to separate a conductor that will be field-installed from:

a) A conductor of any other circuit that will be field-installed;

b) A conductor of any other circuit that is factory installed;

c) A current-carrying part of any other circuit; and

d) A current-carrying part of the same circuit when the risk of fire, electric shock, or injury to persons can result from short-circuiting of the current-carrying part.

Exception No. 1: The barriers for (a) and (b) are not required when the conductors involved are insulated for the maximum voltage of either circuit.

Exception No. 2: The barriers for (c) and (d) are not required when the field-installed conductors will be general wiring or fixture wires rated for 90 °C (194 °F) and 600 volts.

Exception No. 3: The barrier for (d) is not required if:

a) The field-installed conductor will have insulation rated for a voltage not less than that for Type T or equivalent;

b) The circuit is low-voltage as defined in 14.7.1; and

c) Short-circuiting of the current-carrying part will not result in the risk of fire, electric shock, or injury to persons.

Exception No. 4: The barriers are not required when the necessary separation is accomplished by arranging the location of the openings in the enclosure for the various conductors such that there is no possibility of the intermingling of the conductors or parts of different circuits. When the minimum number of openings in the enclosure for proper wiring of the heater are provided and are located opposite a set of terminals, it is assumed the conductors will enter such openings and be connected to the opposite terminals. When more than the minimum number of openings are provided, reasonable alternative wiring possibilities are to be investigated by wiring the heater as it would be wired in service, leaving reasonable slack in each conductor and using not more than average care in stowing this slack in the wiring compartment.

14.5.5 With regard to (a) and (b) of 14.5.4, a removable barrier or one having openings for the passage of conductors may be used, when instructions for the use of the barrier are a permanent part of the appliance.

Exception: When complete instructions, in conjunction with a wiring diagram, will provide for the intended separation of the line-voltage and low-voltage circuits, the barrier may, upon investigation, be omitted.

14.6 Barrier material and thickness

14.6.1 A barrier used to provide separation of different circuits shall be of metal or insulating material, shall have mechanical strength when exposed or otherwise likely to be subjected to mechanical damage, and shall be held in place. Unclosed openings in a barrier for the passage of conductors shall not be larger than 6.4 mm (1/4 inch) in diameter 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.

14.6.2 A metal barrier shall have a thickness not less than the required thickness of the enclosure metal. A barrier of insulating material shall not be less than 0.71 mm (0.028 inch) thick and shall be of greater thickness when its deformation may be readily accomplished so as to defeat its purpose.

14.7 Low-voltage circuits

14.7.1 A low-voltage circuit is one involving a potential of not more than 30 volts rms (42.4 volts peak) and is supplied by:

a) A primary battery;

b) A standard Class 2 transformer; or

c) A suitable combination of a transformer and a fixed impedance that, as a unit, complies with all the performance requirements for a Class 2 transformer.

Exception: A circuit derived from a source of supply classified in 14.8.1 as a line-voltage circuit, by connecting resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low-voltage circuit.

14.7.2 General-purpose transformers shall comply with UL 5085-1; and UL 5085-2.

Exception No. 1: A transformer that is completely enclosed within the end product enclosure, and that meets the applicable construction and performance requirements of this end product standard when tested in conjunction with the end product, meets the intent of this requirement.

Exception No. 2: A transformer that complies with UL 1411, and that is used in a circuit involving an audio or video component, meets the intent of this requirement.

14.7.3 Class 2 and Class 3 transformers shall comply with UL 5085-3.

Exception: Transformers located in a low voltage circuit, and that do not involve a risk of fire or personal injury, need not comply with this requirement.

14.8 Line-voltage circuits

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

15 Heating Elements

15.1 General

15.1.1 A heating element shall be supported in a substantial and reliable manner.

15.1.2 In determining when a heating element complies with the requirement in 15.1.1, 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.

15.1.3 A heater in which the heating element is intended for operation only in an air blast shall be wired or controlled so that the element can be operated only while under the cooling effect of the blast. A heater in which the cooling effect of the motion of a part is necessary to reduce the risk of excessive temperatures shall be wired or controlled so that the element cannot be operated without such motion.

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

a) UL 499; or

b) UL 1030.

15.2 Guarding of heating elements

15.2.1 The heating element and any part of the element assembly (such as an element support, sheath, and the like) shall be guarded so that combustible material as well as persons will be restricted from contacting it.

15.2.2 The evaluation of a guard is made with regard to its general serviceability and to the shape or size, or both, of the openings in it, in conjunction with the distance of the guard from the heating element and parts operating at a temperature of more than 280 °C (536 °F). An opening in a guard may be used if, with the heater in any intended operating position, the shape and size of any opening is such that a test gage in the form of a right-circular cone having a base diameter of 69.9 mm (2-3/4 inches) and a height of 139.7 mm (5-1/2 inches) is restricted from touching any component or part of the heater operating at more than 280 °C when the gage is inserted, apex first, as described in 15.2.3.

15.2.3 When rocks are provided by the manufacturer, or recommended by the operating instructions, they are to be in place in accordance with the manufacturer's instructions while temperature measurements are made to determine those components or parts that operate at a temperature greater than 280 °C (536 °F). After this determination is made, the rocks are to be removed and the cone gage described in 15.2.2 is to be applied in an attempt to contact any component or part of the heater previously determined to operate at a temperature greater than 280 °C. No attempt is to be made to distort a guard when using the gage.

15.2.4 When a heater is required to have a guard for resistance to unintentional contact or for compliance with 42.3.1, either the guard shall be permanently fastened in place by welding, riveting, or the equivalent (bolting is not to be used) or the heater shall be marked as specified in 50.24.

16 Electrical Insulation

16.1 An insulating washer, bushing, and the like, that is an integral part of a heater and a base or support for the mounting of current-carrying parts, shall be of a moisture-resistant material that will not be damaged by the temperatures to which it will be subjected under conditions of actual use. A molded part shall be constructed so that it will have the mechanical strength and rigidity to withstand the stresses of actual service.

16.2 Insulating material used in a heater is to be evaluated with regard to its particular application. Materials such as mica, some molded compounds, and certain refractory materials are capable of being used as the sole support of current-carrying parts; and some other materials not for general use, such as magnesium oxide, are capable of being employed when used in conjunction with other more appropriate insulating materials, or when located and protected so that mechanical damage is restricted and absorption of moisture is reduced. When it is required to investigate a material to determine whether it is capable of being used, the following are to be evaluated:

a) Mechanical strength;

b) Dielectric properties;

c) Insulation resistance (in accordance with 17.7 and 39.1);

d) Heat-resistant qualities;

e) The degree to which it is enclosed or protected; and

f) Any other features having a bearing on the risk of fire, electric shock, or injury to persons involved;

in conjunction with conditions of actual service. All these factors are evaluated with regard to thermal aging.

16.3 A screw or other fastening used for mounting or supporting small, fragile insulating parts shall not be tight enough to cause cracking or breaking of these parts with expansion and contraction. Generally, such parts shall be slightly loose.

16.4 Materials used in a Class 105 (A) insulation system shall comply with 16.9 – 16.11 and Table 16.1. The component requirements for film coated wire and Class 105 (A) insulation systems are not specified.

Table 16.1
Primary Class A Insulating Materials and Minimum Thicknesses

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

16.5 Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with UL 1446. Film coated wire in intimate combination with one or more insulators, and incorporated in an insulation system rated Class 120 (E) or higher, shall comply with the magnet wire requirements in UL 1446.

16.6 All insulation systems employing integral ground insulation shall comply with the requirements specified in UL 1446.

16.7 Class A insulation systems shall consist of a combination of magnet wire and major component insulation materials evaluated and found to operate as intended in its end use. Thermoset materials and materials in Table 16.1 at the thicknesses specified are permitted to be used without further evaluation.

16.8 For Class A insulation systems employing other materials or thinner materials than those indicated in Table 16.1 or a combination of materials, the materials, whether polymeric or not polymeric (treated cloth, for example), shall comply with the requirements in 16.9 – 16.11 and Table 16.1.

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

16.10 Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with UL 1446.

16.11 All insulation systems employing integral ground insulation shall comply with the requirements specified in UL 1446.

17 Thermal Insulation

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

17.2 Thermal insulation that is flexible shall be mounted or supported so that it will not sag. Adhesive material used for mounting thermal insulation shall be rated for use at the temperature to which it may be subjected.

17.3 An adhesive is not required to be evaluated when 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).

17.4 Combustible thermal insulation or other combustible material is not to be used when it is located so that it may be in a current of air within the heater.

17.5 Combustible or electrically-conductive thermal insulation shall not make contact with current-carrying parts of a heater.

17.6 Some types of mineral-wool thermal insulation contain conductive impurities in the form of slag, which should not be used when it contacts current-carrying parts.

17.7 A unit using thermal insulation, such as mineral wool in contact with current-carrying parts or electrical insulation material that is likely to be adversely affected by moisture under the conditions of intended use, shall comply with the Insulation Resistance Test, Section 39.

18 Motors

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

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

18.3 With reference to the requirement in 18.2, 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 material shall be provided with impregnation or otherwise treated to reduce the risk of moisture absorption.

18.4 General-purpose type motors having a NEMA frame size shall comply with UL 1004-1. This includes fractional HP motors rated up to 1 HP (typically NEMA frame sizes 42, 48, or 56), and integral HP motors rated 1 HP and greater (typically NEMA frame sizes 140 – 449T). Component motors are not required to fulfill this requirement.

18.5 Motors located in a low voltage circuit are evaluated for the risk of fire and personal injury in accordance with the applicable requirements of this end product standard.

18.6 Low voltage component fans that comply with UL 507, are considered to fulfill the requirements of Section 18.

19 Overcurrent Protection

19.1 A heater using resistance-type heating elements 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 protective device shall be factory-installed within or on the appliance enclosure, or provided as a separate assembly by the appliance manufacturer.

19.2 It is assumed that the rating of the branch-circuit overcurrent protection device will be 150 % of the rating of the heater unless the heater is marked to specify the use of a protective device having a lower rating. Standard ampere ratings for overcurrent protective devices are 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, and 200. When 150 % of the rating of the heater does not equal one of the standard overcurrent-protective device ratings specified, it is assumed that the next lower rating or setting of overcurrent-protective device will be used.

19.3 The overcurrent protection specified in 19.1, 19.2, and 21.1 – 23.6 shall be of a type rated for branch-circuit protection. When a fuse is provided as the overcurrent protection specified in 19.1, 19.2, and 21.1 – 23.6, it shall be a Class G, H, J, K, or Type S or Edison-base plug fuse.

20 Motor-Running Overcurrent Protection

20.1 A heater using a fractional-horsepower motor (one rated for less than 746 W output) and intended to be remotely or automatically controlled, or a permanently-connected, continuous-duty, manually-started heater using a fractional-horsepower motor (one rated for less than 746 W output) shall incorporate thermal or overcurrent protection that will restrict the motor from attaining excessively high temperatures under any operating conditions.

20.2 The overload protection required by 20.1 shall consist of one of the following:

a) Thermal or overcurrent protection that complies with both the running overcurrent and locked rotor protection requirements in UL 1004-3;

b) Electronic protection that complies with the requirements of UL 1004-7;

c) Electronic overcurrent protection provided as part of a motor-drive complying with UL 61800-5-1. The combination of the motor and the motor drive shall comply with the running overcurrent and locked rotor protection requirements specified in UL 1004-7;

d) Impedance protection complying with the requirements in UL 1004-2; or

e) Electronic protection that complies with the tests of UL 1004-3 and the Protective Electronic Circuit requirements of Annex A, UL 60335-1 Based Requirements for the Evaluation of Electronic Circuits.

20.3 Fuses shall not be used as motor-overcurrent protective devices unless the motor can pass the applicable tests with the largest size fuse that can be inserted in the fuseholder.

21 Ground-Fault, Arc-Fault, and Leakage Current Detectors / Interrupters

21.1 Ground-fault circuit-interrupters (GFCI) for protection against electrical shock shall comply with UL 943.

21.2 Appliance-leakage-current interrupters (ALCI) for protection against electrical shock shall comply with UL 943B. An ALCI is not considered an acceptable substitute for a GFCI when NFPA 70 requires a GFCI.

21.3 Equipment ground-fault protective devices shall comply with UL 1053, and the applicable requirements of UL 943.

21.4 Arc-fault circuit-interrupters (AFCI) shall comply with UL 1699.

21.5 Leakage-current detector-interrupters (LCDI) and any shielded cord between the LCDI and appliance shall comply with UL 1699.

22 Fuses and Circuit Breakers

22.1 Fuses shall comply with UL 248-1; and its applicable subsequent Parts (for example, UL 248-2, UL 248-4, UL 248-5). Defined use fuses that comply with UL 248-1 and another appropriate UL standard for the fuse are considered to fulfill this requirement.

22.2 Fuseholders shall comply with UL 4248-1, and its applicable subsequent Parts of (for example, UL 4248-4, UL 4248-6, UL 4248-9).

22.3 When provided, circuit breakers shall comply with UL 489.

Exception: Circuit breakers used in telecommunications circuitry that comply with UL 489A, need not comply with UL 489.

22.4 Circuit breakers having integral ground fault circuit interrupter capability for protection against electrical shock shall additionally comply with UL 943.

23 Short-Circuit Protection

23.1 When a heater is rated at more than 16 amperes, any motor associated with it shall be protected by an overcurrent device having a maximum ampere rating in accordance with NFPA 70. Such overcurrent protection shall be provided as a part of the heater appliance unless it can be determined that equivalent overcurrent protection would be incorporated as the branch-circuit protective device.

Exception: A motor having an inherent thermal protector that complies with the requirements for such devices may be used with regard to the requirements in this paragraph if, in the appliance, it will be connected in series with a branch-circuit overcurrent protective device 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.

23.2 Overcurrent protection at not more than 20 amperes shall be provided by a circuit breaker or fuse as a part of a heater for each general-use duplex receptacle circuit, each transformer primary circuit, and 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.

Exception: The overcurrent protection may be omitted from the primary of a Class 2 transformer and from the primary of any other transformer when there is no emission of flame or molten metal from the heater enclosure, or emission of dense smoke in an occupancy compartment, when the transformer is operated under the conditions described in 21.5.

23.3 Overcurrent protection at not more than 15 amperes shall be provided by a fuse or circuit breaker for each general-use single receptacle unless the heater is intended for connection to a branch circuit rated at 15 amperes.

23.4 When a circuit breaker handle is operated vertically rather than rotationally or horizontally, the up position of the handle shall be the on position.

23.5 The transformer is to be operated continuously at the test voltage indicated in Table 37.3 and at rated frequency with the enclosure grounded. The load connected to the output terminals is to be a resistance of such value that three times the full load of rated current will be drawn from the secondary

windings; operation is to be continued until constant temperatures are 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 at not less than that required for the heater.

Exception: The test is to be conducted with the output terminals of the transformer short-circuited when such condition results in less than three times its rated current being drawn from the secondary. When the transformer controls a motor, and the motor- locked rotor load plus the additional load on the transformer is greater than three times the full-load rated current, the test is to be conducted with the output terminals connected to the motor with the rotor locked, and the other loads are parallel. When the transformer does not control a motor, the load imposed on the transformer is determined by the coils of any solenoids, relays, or the like, with the armature of the larger of such devices blocked open. The test is to be conducted with an equal resistance load substituted for the coil when this load is greater than three times the full-load rated current. When accessible fuses are provided on the transformer, they are to be replaced with dummy fuses, but inaccessible fuses are to remain in the circuit.

23.6 A fuse or circuit breaker provided as a part of a heater shall be rated for the particular application and shall not be accessible from outside the heater without opening a door or cover. A fuseholder for a plug fuse shall be constructed and installed so that live parts will not be exposed to contact by persons removing or replacing fuses.

Exception No. 1: The operating handle of a circuit breaker may project outside the enclosure.

Exception No. 2: A fuse holder with a removable end cap may have the end cap accessible outside the enclosure.

Exception No. 3: The screw shell of a fuseholder for a plug fuse may be exposed to contact during removal or replacement of the fuse.

23.7 A fuseholder shall be constructed and installed so that no uninsulated live parts other than the screw shell or clips are exposed to contact by a person removing or replacing a fuse. The screw shell of a plug-type fuseholder, and the accessible contact of an extractor-type fuseholder, shall be connected toward the load.

24 Light Sources and Associated Components

24.1 Lampholders and indicating lamps shall comply with UL 496.

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

24.2 Lighting ballasts shall comply with the:

a) UL 935; or

b) UL 1029.

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

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

24.3 Light emitting diode (LED) light sources shall comply with UL 8750.

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

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

25 Lampholders

25.1 An Edison-base type lampholder supplied as a part of the heater shall be wired so that the screw shell will be connected to the identified grounded conductor of the supply.

25.2 A lampholder shall be constructed and installed so that no live part other than the screw shell will be exposed to contact by persons removing or replacing lamps during service.

Exception: The requirement in this paragraph does not apply when, in order to remove or replace a lamp, it is necessary to dismantle the heater with a tool as described in 50.10.

26 Switches

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

26.2 Manually operated snap-switches shall comply with one of the following, as applicable:

a) UL 61058-1;

b) UL 20; or

c) UL 773A.

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

26.3 Switches that comply with UL 61058-1, shall be rated as specified in 26.2 – 26.4.

26.4 Power switches shall be rated as follows:

a) For a voltage not less than the rated voltage of the appliance;

b) For a current not less than the rated current of the appliance;

c) For continuous duty;

d) With respect to load:

1) A combination resistive load with a motor load at a power factor not less than 0.6 in accordance with UL 61058-1 if the switch would encounter this load in normal use; or

2) Switches may have a declared specific load in accordance with UL 61058-1 and may be considered based upon the load conditions encountered in the appliance under normal load.

e) For ac, if the appliance is rated for ac;

f) For dc, if the appliance is rated for dc.

26.5 Ratings and load classifications for switches other than power switches shall be based on the conditions encountered in the appliance under normal load.

26.6 Switches shall also be rated with respect to endurance as follows:

a) Power switches: 6000 cycles;

b) Power switches provided with series electronics shall be subject to an additional 1000 cycles of operation with the electronics bypassed;

c) Switches other than power switches, such as speed selector switches, that may be switched under electrical load: 1000 cycles;

d) The following non-power switches are not required to be rated for endurance:

1) Switches not intended for operation without electrical load, and which can be operated only with the aid of a tool or are interlocked so that they cannot be operated under electrical load; or

2) Switches for 20 mA load as classified in UL 61058-1.

26.7 A clock-operated switch, in which the switching contacts are actuated by a clock-work, by a gear-train, by electrically-wound spring motors, by electric clock-type motors, or by equivalent arrangements shall comply with one of the following:

a) UL 60730-1 and UL 60730-2-7; or

b) UL 917.

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

a) UL 60730-1 and UL 60730-2-7; or

b) UL 244A.

26.9 A switch shall be located or protected so that it will not be subjected to physical damage during use.

26.10 It is recommended that each switch be of the indicating type.

26.11 When a switching device (or a pilot device controlling it) has a marked on or off position (or both), and operates to interrupt the main power supply circuit to a heater, it shall, when open, disconnect all ungrounded conductors of the supply circuit.

26.12 A switching device as described in 26.11, but without a marked on or off position, shall comply with the requirement in 26.11 unless there is no uninsulated current-carrying part exposed to unintentional contact when the switching device is open, or the fact that such part is live is definitely apparent.

26.13 When a switch is operated vertically rather than rotationally or horizontally, the up position of the switch shall be the on position.

26.14 A switch or other means of control intended to permit the use of a limited number of elements at one time shall be located or be of such a type that the user cannot readily change the connections to permit the use of more elements than intended.

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

26.16 A timed-cutoff switch shall be provided with the heater as indicated in 26.17 and 26.18 unless the heater is marked in accordance with 52.1.

26.17 When a timed-cutoff switch is installed at the factory as an integral part of the heater or control panel, it shall:

a) Be connected so that it will simultaneously disconnect the number of ungrounded conductors required to interrupt the current flow to the heater;

b) Have a maximum "on" period of 1 hour; and

c) Be arranged and installed so that the time feature does not lend itself to being overridden.

26.18 When a timed-cutoff switch is shipped with the heater, the switch shall be rated for the application and shall be of such construction that it can be installed in accordance with the markings specified in 52.1.

27 Receptacles

27.1 No receptacle shall be provided as part of a heater or inside a combination heater-room, as specified in 52.2.

28 Printed Wiring Boards

28.1 Printed wiring boards, including the coatings, shall comply with UL 796.

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

28.2 A printed-wiring board containing circuitry in a line-connected circuit or a safety circuit shall comply with the direct-support requirements for insulating materials in Section 15 of this end product standard.

28.3 Unless otherwise specified, the flammability class and temperature rating shall be that specified for insulating materials in Section 15 of this end product standard.

29 Semiconductors and Small Electronic Components

29.1 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with UL 1557. The dielectric voltage withstand tests required by UL 1557 shall be conducted applying the criteria of Section 40 of this end product standard.

29.2 An optical isolator that is relied upon to provide isolation between primary and secondary circuits or between other circuits as required by this end product standard shall comply with UL 1577. The dielectric voltage withstand tests required by UL 1577 shall be conducted applying the criteria of Section 40 of this end product standard.

29.3 Except as specified in 29.4, component requirements are not specified for small electronic components on printed wiring boards, including diodes, transistors, resistors, inductors, integrated circuits, and capacitors not directly connected to the supply source.

29.4 An electronic, non-protective circuit that is simple in design need only be subjected to the applicable requirements of this end-product standard. A control that does not include an integrated circuit or microprocessor, but does consist of a discrete switching device, capacitors, transistors, and resistors, is considered simple in design. See 42.6.

30 Automatic Temperature Controls

30.1 General

30.1.1 A heater shall be provided with two independent temperature controls:

a) An automatic temperature-regulating control that is either an integral part of the heater or that is a separate component for installation as part of the room assembly and

b) A manual-reset limit control that is integral with the heater.

30.1.2 With reference to 30.1.1, when contactors are used, separate contactors shall be used for the automatic temperature-regulating control and the manual-reset limit control.

30.1.3 The manual-reset limit control shall comply with the requirements in UL 353 or UL 873, as a Type M1 action control or a single operation device control. Compliance with UL 60730-1, in conjunction with UL 60730-2-9, as a Type 1.D or 1.H action protective control fulfills the UL 873 requirements. The control shall comply with 30,000 cycles of endurance.

Exception: For a heater intended for household use only, the manual-reset limit control shall comply with 6000 cycles of endurance, and be marked in accordance with 50.28.

30.1.4 The automatic temperature-regulating control shall comply with the requirements in UL 353 or UL 873. Compliance with UL 60730-1, in conjunction with UL 60730-2-9, as a Type 2 action operating control fulfills the UL 873 requirements. The control shall comply with the 100,000 cycles of endurance.

30.1.5 The manual-reset limit control shall be secured in place and located so that it will be accessible for resetting without disturbing internal wiring. No current-carrying part shall be accessible during resetting of the control.

30.1.6 Each of the control devices described in (a) – (c), when in the disconnect position, shall interrupt power to the element(s) it controls from all ungrounded conductors of the power supply circuit:

a) A manual-reset limit control.

b) An automatic temperature-regulating control that has a marked position indicating "off" or the equivalent.

c) An automatic temperature-regulating control without a marked position indicating "off" or the equivalent, that controls a live part exposed to unintentional contact, the live condition of which is not apparent.

30.1.7 A control intended to reduce the risk of fire, electric shock, or injury to persons in operation of a heater shall be operative whenever the heater is connected to its power supply.

30.1.8 A contactor actuated by a control shall comply with the endurance test requirements for the control. Refer to 30.1.3 and 30.1.4 for the number of cycles.

30.1.9 When a control has a marked position as described in 30.1.10, it shall not respond to temperature changes while the actuating member is in that position.

30.1.10 The requirement in 30.1.9 applies to a control that is marked:

a) With an "Off" position or

b) With another wording (such as "No heat," "Cold," or the like) that conveys the same meaning as the word "Off".

30.1.11 A control that does not reclose (remains open) when cooled to a temperature of minus 35 °C (minus 31 °F) may be used with regard to the requirement in 30.1.9.

30.2 Terminals and actuating members of temperature controls

30.2.1 The terminals of a temperature control within the enclosure of a heater shall be located or further enclosed to reduce the risk of their becoming short-circuited or damaged.

30.2.2 The bulb, capillary tubing, or other sensing element of a control or limit switch that is depended upon to reduce the risk of fire, electric shock, or injury to persons shall be located or guarded against physical damage during installation and use of the heater.

30.2.3 The bulb, capillary tubing, or other sensing element of an automatic temperature-regulating control that is a separate component for installation in a room shall be provided with a guard to reduce the risk of it becoming physically damaged.

30.2.4 The guard for the sensing element and for any exposed capillary tubing shall reduce the risk of physical damage and be fastened in place by screws, nails, or the equivalent.

30.2.5 The guard may be metallic or nonmetallic, but no metallic portion shall be exposed to contact more than 305 mm (12 inches) below the ceiling of the room.

31 Liquid Level Controls

31.1 A liquid level control relied upon to comply with this Standard shall comply 30.1.2 – 30.1.9.

32 Pressure Controls

32.1 A pressure control relied upon to comply with this Standard shall comply 30.1.2 – 30.1.9.

33 Spacings

33.1 General

33.1.1 Each spacing in a heater shall be in accordance with Table 33.1 – Table 33.3.

Exception No. 1: The spacings specified in the tables do not apply to the inherent spacings of a component part of a heater. Such spacings are evaluated under the requirements for that component.

Exception No. 2: At closed-in points only, such as the screw-and-washer construction of an insulated terminal mounted in metal, a spacing of 1.2 mm (3/64 inch) may be used in a heater rated at 250 volts or less. Within a temperature regulating control, other than at contacts, the spacing between uninsulated current-carrying parts on opposite sides of the contacts is not to be less than 0.8 mm (1/32 inch) through air and 1.2 mm over the surface of insulating material, and the construction is to be such that the spacings will be maintained permanently.

Table 33.1
Minimum Spacings at Field-Wiring Terminals

Parts involved	Potential involved	Through air		Over the surface	
	volts	mm	(inch)	mm	(inch)
Between current-carrying parts of opposite polarity and between a current-carrying part and a noncurrent-carrying part, other than the enclosure, which may be grounded	0 – 250	6.4	(1/4)	9.5	(3/8)
	251 – 600	9.5	(3/8)	12.7[a]	(1/2)[a]
Between a current-carrying part and the enclosure	0 – 600	12.7	(1/2)	12.7	(1/2)
NOTES 1 The spacings do not apply to connecting straps or buses extending away from wiring terminals. Such spacings are to be evaluated using Table 33.2. 2 Applies to the sum of the spacings involved where an isolated dead part is interposed.					
[a] A spacing of not less than 9.5 mm (3/8 inch), through air and over the surface, may be used at wiring terminals in a wiring compartment or terminal box if the compartment or box is integral with the motor.					

Table 33.2
Minimum Spacings Through Air or Over the Surface at Points Other Than Field-Wiring Terminals or Inside Motors

Parts involved	Potential involved, volts	mm	(inch)
Between current-carrying parts of opposite polarity and between a rigidly mounted uninsulated current-carrying part and a noncurrent-carrying conductive part that either is exposed to contact by persons or may be grounded	0 – 250	1.6	(1/16)
	251 – 600	6.4[a,b]	(1/4)[a,b]
NOTE – When a current-carrying 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 spacing of 1.6 mm (1/16 inch) is maintained under all operating conditions and under all intended handling conditions. 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.			
[a] Film-coated wire is considered to be a live part. However, a spacing of not less than 2.4 mm (3/32 inch) over the surface and through air may be used between a dead-metal part and film-coated wire rigidly supported and held in place on a motor coil. [b] A spacing of 1.6 mm (1/16 inch) is permissible at the heating element only, in a heater rated 300 volts or less.			

Table 33.3
Minimum Internal Motor Spacings at other Than Field-Wiring Terminals

Potentials at the points between which the spacings are measured	Parts involved	Diameter of motor frame[a]	Through air and over the surface, mm	(inch)
0 – 125 volts	Commutator or collector rings	178 mm (7 inches) or less	1.6	(1/16)
	Elsewhere in the motor		2.4[b]	(3/32)[b]
126 – 250 volts	Commutator or collector rings	178 mm (7 inches) or less	1.6	(1/16)
	Elsewhere in the motor		2.4	(3/32)
251 – 600 volts	Commutator or collector rings and live parts of the brush rigging	178 mm (7 inches) or less	6.4[c]	(1/4)[c]
	Elsewhere in the motor		6.4[d]	1/4)[d]

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

[b] For a motor rated 1/3 horsepower (249 W output) or less, the spacing may not be less than 1.6 mm.

[c] A spacing involving a collector ring may not be less than 3.2 mm (1/8 inch).

[d] Film-coated wire is considered to be an uninsulated live part. However, a spacing of not less than 2.4 mm – over the surface and through air – may be used between film-coated wire (rigidly supported and held in place on a coil) and a noncurrent-carrying conductive part.

33.1.2 Each spacing within a motor connected across a portion of a resistance element or in series with a reactor or an autotransformer shall be in accordance with the full rated voltage of the heater.

33.2 Barriers

33.2.1 An insulating lining or barrier of fiber or similar material used where spacings would otherwise be less than the required values shall not be less than 0.8 mm (1/32 inch) thick and shall be located or of such material so that it will not be adversely affected by arcing.

Exception No. 1: Fiber not less than 0.4 mm (1/64 inch) thick may be used in conjunction with an air spacing of not less than 50 % of the spacing required for air alone.

Exception No. 2: Insulating material having a thickness less than that specified in this paragraph is not prohibited from being used when, upon investigation, it is determined to be acceptable for the particular application.

33.2.2 Unless made resistant to physical abuse during assembly and intended functioning of the heater, an insulating lining or a barrier of mica shall not be less than 0.25 mm (0.01 inch) thick.

34 Clearance and Creepage Distances

34.1 As an alternative approach to the spacing requirements specified in Spacings, Section 33, and other than as noted in 34.2 and 34.3, clearances and creepage distances may be evaluated in accordance with the requirements in UL 840, as specified in 34.4.

34.2 Clearances between an uninsulated live part and the walls of a metal enclosure, including fittings for conduit or armored cable, shall be as specified in Table 33.2. The clearances shall be determined by physical measurement.

34.3 The clearance and creepage distance at field-wiring terminals shall comply with Table 33.1.

34.4 When conducting evaluations in accordance with the requirements in UL 840, the following criteria shall be used:

a) For evaluating clearances:

1) Units intended to be permanently wired to their supply shall be evaluated for Overvoltage Category II;

2) The phase-to-ground rated system voltage used in the determination of clearances shall be the equipment rated supply voltage rounded to the next higher value;

3) To determine equivalence with current through air spacings requirements, an impulse test potential having a value as determined in UL 840, shall be used.

b) For evaluation of creepages:

1) Any printed-wiring board which complies with the requirements for Direct Support in UL 796 provides a Comparative Tracking Index (CTI) of 100;

2) Printed-wiring boards are evaluated as Pollution Degree 2 when adjacent conductive material is covered by any coating, such as a solder mask, which provides an uninterrupted covering over at least one side and the complete distance up to the other side of conductive material;

3) Printed-wiring boards shall be evaluated as Pollution Degree 1 under one of the following conditions:

i) A coating which complies with the requirements in UL 746C; or

ii) At a specific printed-wiring board location by application of at least a 1/32 inch (0.79 mm) thick layer of silicone rubber or through potting, without air bubbles, in epoxy or potting material.

35 Grounding and Bonding

35.1 All exposed dead metal parts and all dead metal parts inside the enclosure that are exposed to contact during any servicing operation (including maintenance and repair), and that are likely to become energized under abnormal conditions, shall be reliably bonded to the point of connection of the field equipment grounding terminal or lead and to the metal surrounding the knockout, hole, or bushing provided for the field connection of the wiring system.

Exception No. 1: A small metal part, such as an adhesive-attached metal foil marking, a screw, a handle, or the like, that is:

a) Located on the outside of an enclosure or cabinet and isolated from electrical components or wiring by grounded metal parts so that it is not likely to become energized or

b) Separated from wiring and spaced from uninsulated live parts as if it were a grounded part,

is not required to be bonded.

Exception No. 2: A metal panel or cover is not required to be bonded when:

a) The panel or cover is insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or other moisture-resistant material not less than 0.8 mm (1/32 inch) thick and secured in place or

b) The panel or cover does not enclose live parts, and wiring is positively separated from the panel or cover so that it is not likely to become energized.

Exception No. 3: Cord-connected equipment may be provided with a system of double insulation in accordance with UL 1097, in lieu of grounding.

35.2 Unless each exposed dead metal part is bonded together by the use of a mechanical fastener, a separate bonding conductor shall be used.

35.3 The bonding conductor shall be of material sized and rated for use as an electrical conductor and shall be resistant to corrosion. Separate bonding conductors or straps shall be installed such that there is a reduction in the risk of mechanical damage.

35.4 The bonding shall be by a positive means, such as clamping, riveting, bolted or screwed connection, brazing, or welding. The bonding connection shall reliably penetrate nonconductive coatings such as paint. Bonding around a resilient mount shall not depend on the clamping action of rubber or similar material unless the construction has been shown by investigation to be acceptable for such use. In the investigation, overcurrent, short-circuit, and aging tests may be conducted.

35.5 The size of a conductor or strap used to bond an electrical enclosure or motor frame shall be based on the rating of the branch circuit overcurrent device to which the equipment will be connected. The size of the conductor or strap shall be in accordance with Table 35.1.

Exception: A smaller conductor may be used when the bonding connection does not open when carrying for 2 minutes twice the current equal to the rating of the branch circuit overcurrent device. A bonding conductor to a motor is not required to be larger than the size of the motor circuit conductors.

Table 35.1
Size of Bonding Conductor or Strap

Size of bonding conductor[a]				Rating of overcurrent device amperes
Copper wire		Aluminum wire		
mm^2	(AWG)	mm^2	(AWG)	
2.08	(14)	3.31	(12)	15
2.08	(14)	3.31	(12)	20
3.31	(12)	5.26	(10)	30
5.26	(10)	8.37	(8)	60
8.37	(8)	13.30	(6)	100
13.30	(6)	21.15	(4)	200

[a] Or equivalent cross-sectional area.

35.6 When more than one size of branch-circuit overcurrent device is involved, the size of the bonding conductor is to be based on the rating of the overcurrent device intended to provide ground-fault protection for the component bonded by the conductor. For example, when a motor is individually protected by a branch-circuit overcurrent device smaller than other overcurrent devices used with the equipment, a bonding conductor for that motor is sized on the basis of the overcurrent device intended for ground-fault protection of the motor.

PERFORMANCE

36 Power Input Test

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

36.2 To determine heater compliance with the requirements in 36.1, the power input is to be measured with the heater at intended operating temperature under full-load conditions and while connected to a supply circuit of rated voltage in accordance with 37.8. When a heater uses a nonmetallic element (such as carbon), the power input is to be determined when the element is new.

37 Temperature Test

37.1 A heater, when tested under the conditions described in 37.8 – 37.14, shall not attain a temperature at any point high enough to constitute the risk of fire, electric shock, or injury to persons or to damage any material used in the heater. Temperatures at specific points shall not exceed those indicated in Table 37.1 and 37.13.

Table 37.1
Maximum Temperatures

Material or component	°C	(°F)
1. Any point within a terminal box or wiring compartment in which field-installed conductors are to be connected, including such conductors themselves	90	(194)
2. Any point on a surface adjacent to a heater (including the surface on which the heater is mounted and the guard), 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 comes into contact with combustible material within the test enclosure	90	(194)
3. Fuses:		
a) Class J, T, CC	110	(230)
b) Class R	75	(167)
c) Other fuses	90	(194)
4. Fiber used as electrical insulation or as cord bushings	90	(194)
5. Wood or other combustible material that is a part of the heater	90	(194)
6. Cotton or rayon braid of a flexible cord	90[a]	(194)[a]
7. Class 105 insulated relay or solenoid winding	90[b]	(194)[b]
8. Class A insulation on coil windings of DC, universal, and integral-horsepower motors[c]:		
a) In open motors:		
Thermocouple method	90	(194)
Resistance method	100	(212)
b) In totally enclosed motors:		
Thermocouple method	95	(203)
Resistance method	105	(221)
9. Class A insulation on coil windings of fractional-horsepower AC motors, other than universal, and on vibrator coils – thermocouple or resistance method[c]:		
a) In open motors	100	(212)
b) In totally enclosed motors	105	(221)

Table 37.1 Continued on Next Page

Table 37.1 Continued

Material or component	°C	(°F)
10. Class B insulation, other than as indicated in items 11 and 12 – thermocouple method[c]	110	(230)
11. Class B insulation on coil windings of DC, universal, and integral-horsepower AC motors[c]:		
a) In open motors:		
Thermocouple method	110	(230)
Resistance method	120	(248)
b) In totally enclosed motors:		
Thermocouple method	115	(239)
Resistance method	125	(257)
12. Class B insulation on coil windings of fractional-horsepower AC motors other than universal – thermocouple or resistance method[c]:		
a) In open motors	120	(248)
b) In totally enclosed motors	125	(257)
13. Phenolic composition used as electrical insulation or where failure results in a condition of risk[d]	150	(302)
14. Insulated wire or cord	The temperature rating of the insulating material[e]	
15. Sealing compound	f	(f)
16. Copper conductors:		
a) Tinned or bare strands having:		
1) A diameter less than 0.38 mm (0.015 inch)	150	(302)
2) A diameter of 0.38 mm or more	200	(392)
b) Plated with nickel, gold, silver, or a combination of these	250	(482)
17. Termination of copper conductor in a pressure terminal connector, unless both are tinned, nickel coated, or silver plated	150	(302)

[a] Inside a heater, the braid of a heater cord is capable of being subjected to a greater temperature when the insulation is held in place by other suitable means.

[b] A maximum temperature of 110 °C (230 °F) complies under the resistance method.

[c] See 37.6 and 37.7 for further thermocouple specification.

[d] The limitation on phenolic composition does not apply to a compound that has been investigated and determined to have complying heat-resistant properties.

[e] Inside a heater, the maximum temperature on a wire or cord is capable of being greater than the specified maximum temperature when the insulation on each conductor is protected by supplementary insulation (such as a braid, wrap, tape, or close-fitting tubing) that is rated for the temperature and type of insulation involved.

[f] Unless the material is thermal-setting, 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 ASTM E 28.

37.2 Temperatures on the room wall or ceiling may be measured as indicated in 37.5 or by attaching a thermocouple to the back of a blackened disc of copper or brass, 15 mm (0.59 inch) in diameter and 1 mm (0.04 inch) thick, that is flush with the surface.

37.3 Each value in Table 37.1 is based on an assumed ambient temperature of 25 °C (77 °F) outside the heater room. The test may be conducted at any ambient temperature within the range of 10 – 40 °C (50 – 104 °F). The variation from 25 °C ambient shall be added to or subtracted from the temperature readings on parts outside the heater room, but no correction shall be made on temperature readings on parts inside the outer surface of the heater room.

37.4 Temperatures are to be measured by thermocouples consisting of wires not larger than 0.21 mm^2 (24 AWG) and not smaller than 0.05 mm^2 (30 AWG). When thermocouples are used in determining temperatures in electrical equipment, it is standard practice to use thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer-type instrument; such equipment is to be used whenever referee temperature measurements by thermocouples are necessary. The thermocouples and related instruments are to be accurate and calibrated in accordance with laboratory practice. The thermocouple wire is to comply with the Special Tolerances thermocouples as listed in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ASTM E230/E230M. A temperature is considered to be constant when three successive readings, taken at intervals of 10 % of the previously elapsed duration of the test (but not less than 5-minute intervals), indicate no change.

Exception: A coil temperature is to be determined by the change-of-resistance method in 37.6 when the coil is inaccessible for mounting thermocouples.

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

37.6 A thermocouple is to be used for determining the temperature of a coil or winding when (without removal of encapsulating compound or the like) it can be mounted on:

a) The integrally applied insulation of a coil without a wrap or

b) The outer surface of a wrap that is not more than 0.8 mm (1/32 inch) 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 when the thermocouple measurement cannot be conducted in accordance with the foregoing considerations. For a thermocouple-measured temperature of a motor coil as specified in items 9 and 12 of Table 37.1, the thermocouple is to be mounted on the integrally applied insulation on the conductor.

37.7 At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature measured by means of a thermocouple may be as shown in Table 37.2 when the temperature of the coil measured by the resistance method is not greater than specified in Table 37.1.

Table 37.2
Points Affected by External Heat Source

Item in Table 37.1	Maximum temperature °C	(°F)
Part (a) of item 8	105	(221)
Part (a) of item 9	105	(221)
Part (a) of item 11	130	(266)
Part (a) of item 12	130	(266)

37.8 To determine heater compliance with the requirement in 37.1, it is to be operated continuously until constant temperatures have been reached. The test voltage is to be as indicated in Table 37.3.

Exception: When 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 37.3
Voltage for Temperature Test

Marked voltage rating	Test potential in volts
Value within one of the specified ranges	Highest value of corresponding specified ranges[a]
Value not within one of the specified ranges	Rated voltage (minimum 120, 208, 240, or 277 depending on nominal branch circuit supply voltage to which heater is to be connected)
[a] Specified range refers to any of the ranges of voltage mentioned in 49.1.	

37.9 A motor that is used in the heater in addition to a heating element is to be operated at the marked voltage rating of the heater, whether integrally connected or on a separate circuit.

37.10 The tests described in 37.1, 42.1.2, and 42.1.3 are to be performed:

a) With rocks (when the manufacturer supplies the rocks, recommends their use in the operating instructions, and provides a marking on the heater in accordance with50.14 to indicate that the rocks are essential to the intended operation); and

b) With and without rocks, when the rocks are not supplied by the manufacturer.

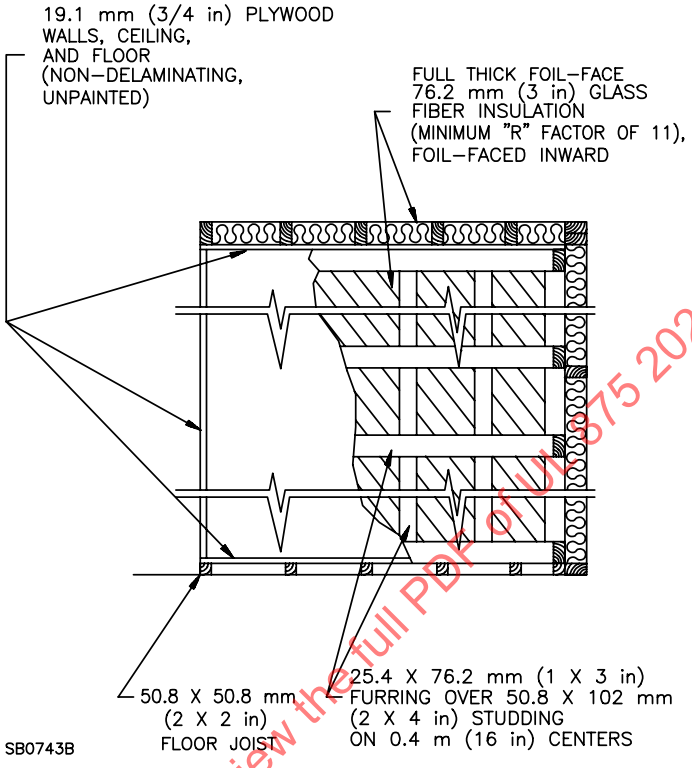
Exception: Constructions for which rocks obviously cannot be used are not required to be tested with rocks.

37.11 When rocks are used in the following tests, the rock compartment in the heater is to be filled with rocks having a density of 2720 – 2960 kg/m^3 (170 – 185 pounds per cubic foot).

37.12 In conducting a test to determine heater compliance with the temperature requirements, the heater is to be mounted or supported as in service and tested under conditions approximating those of intended operation. The heater is to be installed in a room of the minimum size specified by the manufacturer's installation instructions. The walls, ceiling, and the floor of the room shall be constructed of 19.1-mm (3/4-inch) thick, non-delaminating, unpainted plywood on conventional 0.4-m (16-inch) centers using 50.8 by 102 mm (2 by 4 inch) studding and 50.8 by 50.8 mm floor joists with 25.4 by 76.2 mm (1 by 3 inch) furring over the studding. Foil-faced 7.62-mm (3-inch) glass fiber insulation having a minimum R (thermal resistance) factor of 11 is to be stretched, foil-face inward, over the studding flush with the inside surface of the studs. The thermal insulation is to be securely fastened. 19.1 mm square corner trim, 19.1-mm square ceiling trim, and 12.7 by 41.2 mm (1/2 by 1-5/8 inch) base trim are to be used. The outside is to be finished with wood or plywood at least 6.4 mm (1/4 inch) thick. See Figure 37.1.

Figure 37.1

Typical Wall Construction



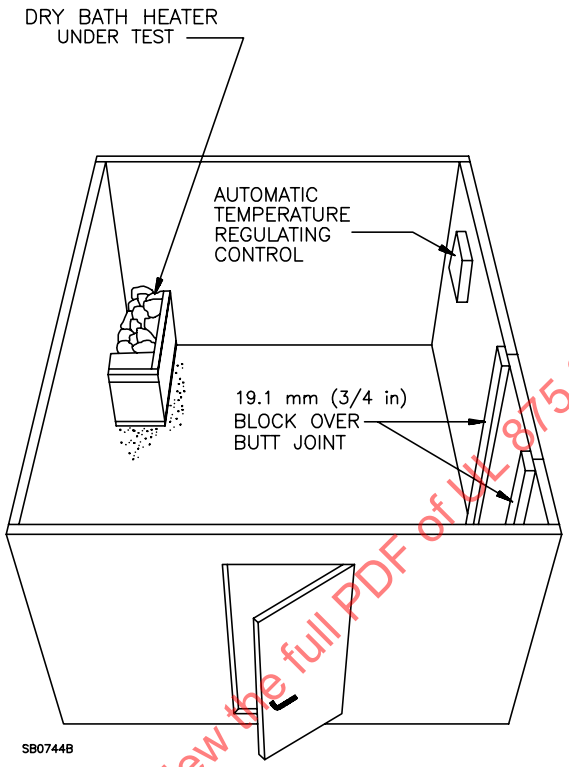
37.13 The heater is to be operated with the door of the test room closed. When vents are provided in the room, they are to be closed during the test. The temperatures on the inner surfaces of the room shall not exceed 120 °C (248 °F) during the first hour of operation and shall not exceed 90 °C (194 °F) at the end of the first hour. The manually-resettable thermal cutoff shall not operate during this test.

37.14 The heater is to be located as close to a wall corner as its construction will permit, and it is to be placed relative to the walls so that maximum heating will occur on the walls. See Figure 37.2.

Exception: The heater may be spaced away from the walls when the heater is marked as described in 50.18.

Figure 37.2

Arrangement of the Heater Test Room



38 Minimum Room Air Temperature Test

38.1 The air temperature inside the test room under stabilized conditions shall be not less than 71 °C (160 °F) when tested in accordance with 38.2.

38.2 In a test to determine compliance with the requirement in 38.1, the test room is to be equipped with a thermocouple centrally located in the room 0.6 m (2 feet) below the ceiling. The heater is to be operated in accordance with 37.8 – 37.14.

Exception: When a series of room sizes, heater sizes, or both, are being represented by the sample under test, the voltage to the heating elements is to be adjusted, when necessary, to attain a ratio of watts to room unit volume equivalent to the lowest ratio of the series.

39 Insulation Resistance Test

39.1 A sample is to be heated to a temperature of 34 °C (93 °F) to reduce the risk of condensation of moisture during conditioning. The heater is then to be placed in a humidity cabinet having a relative humidity of 85 ±5 % at a temperature of 32 ±2 °C (89.6 ±3.6 °F) for 24 hours. After the conditioning:

a) A heater shall have an insulation resistance between live parts and noncurrent-carrying metal parts of not less than 50,000 ohms.

b) A heater shall comply with the requirements when subjected to a repeated Dielectric Voltage-Withstand Test, Section 40.

Exception: A ceiling-recessed heater or ceiling surface-mounted heater is not required to comply with these requirements.

39.2 Insulation resistance is typically to be measured by a megohmmeter providing a test potential of 260 volts DC. The heater is not to be energized for this test.

40 Dielectric Voltage-Withstand Test

40.1 A heater shall withstand without breakdown for 1 minute, the application of a 60-hertz essentially sinusoidal potential between live parts and interconnected dead metal parts with the heater at its maximum intended operating temperature.

40.2 The test potential (rms) is to be 1000 volts for a heater rated 250 volts or less, and 1000 volts plus twice the rated voltage for a heater rated more than 250 volts.

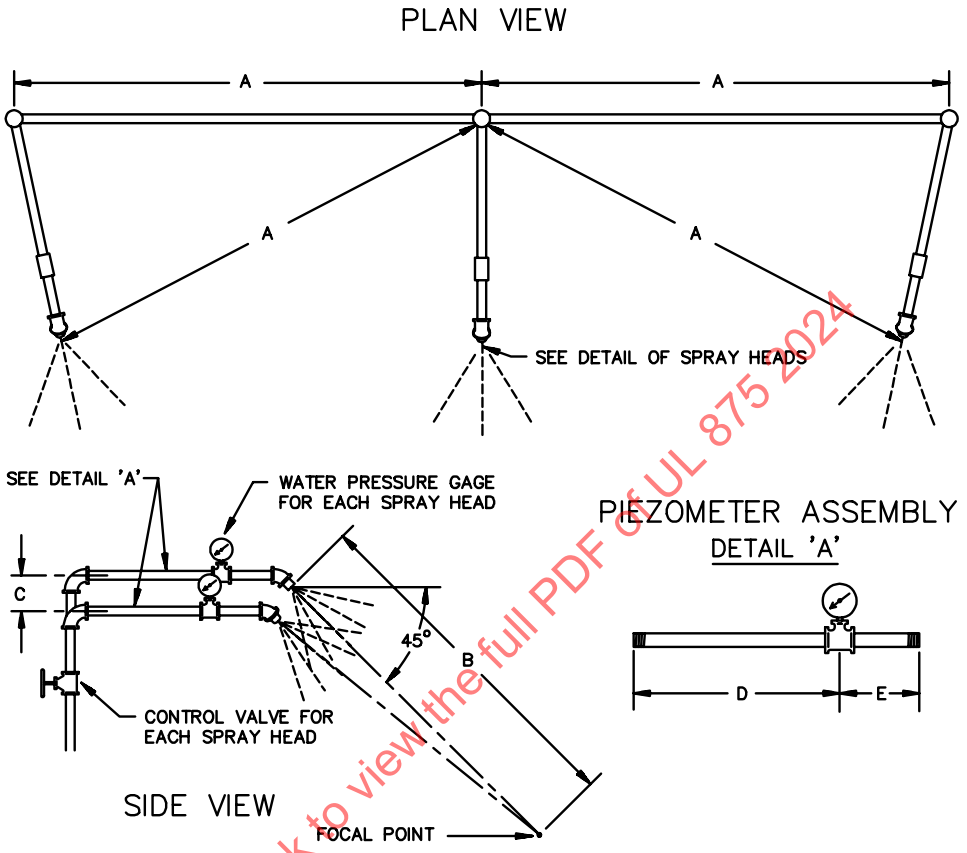
40.3 The test transformer is to have a capacity of 500 volt-amperes or more and an output voltage that is essentially sinusoidal. The applied potentials are to be increased gradually from zero to the required values and then maintained for 1 minute. There shall be no dielectric breakdown as a result of this test.

41 Water Spray Test

41.1 The heater is to be connected to a source of supply having voltage in accordance with Table 37.3 and operated until well heated. The heater is then to be subjected to a water spray test using the apparatus illustrated in Figure 41.1 and Figure 41.2. The spray is to be applied to the top front of the enclosure at an angle of 45 degrees to the vertical. The rate of waterfall is to be 5.36 mm (0.21 inch) per minute as determined by the rise of water in a small pan with vertical sides, placed horizontal and completely within the area covered by the water spray. The water is to have a resistivity of 2540 ohm-centimeters. The spray cycle consists of a 15-second spray and a 105-second drying period. The cycle is to be repeated for 1 hour (total 30 cycles). The heater is then to be de-energized and immediately subjected to the tests described in the Insulation Resistance Test, Section 39, and the Dielectric Voltage-Withstand Test, Section 40.

Figure 41.1

Water-Spray Piping

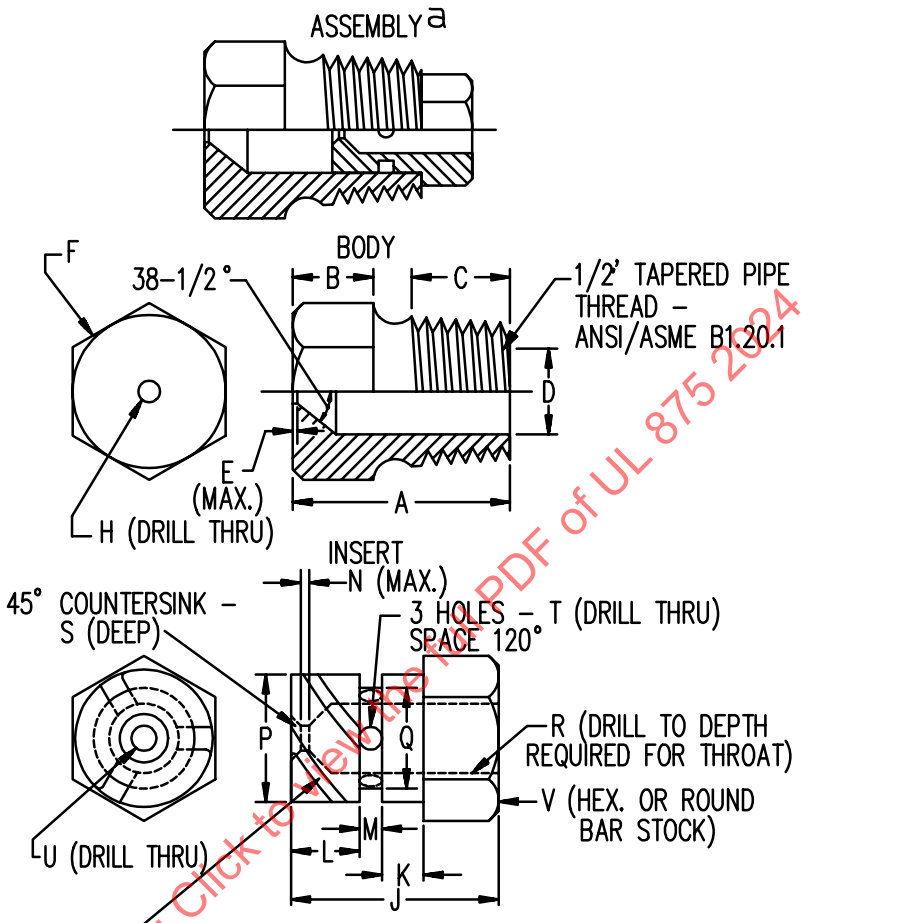


Item	mm	inch
A	710	28
B	1400	55
C	55	2–1/4
D	230	9
E	75	3

RT101H

Figure 41.2

Spray Head



Item	mm	inch	Item	mm	inch
A	31.0	1–7/32	N	0.80	1/32
B	11.0	7/16	P	14.61	.575
C	14.0	9/16		14.63	.576
D	14.68	.578	Q	11.51	.453
	14.73	.580		11.53	.454
E	0.40	1/64	R	6.35	1/4
F	c	c	S	0.80	1/32
G	1.52	.06	T	2.80	(No. 35)[b]
H	5.0	(No.9)[b]	U	2.50	(No. 40)[b]
J	18.3	23/32	V	16.0	5/8
K	3.97	5/32	W	1.52	0.06
L	6.35	1/4			
M	2.38	3/32			

[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.

RT100K

42 Abnormal Operation Test

42.1 Temperature

42.1.1 When the conditions of intended operation are not representative of abnormal conditions likely to occur in actual service, a heater shall be subjected to the tests described in 42.1.2 and 42.1.4. A heater shall not constitute a risk of fire, electric shock, or injury to persons when operated continuously under conditions as described in 42.1.2 – 42.1.4.

42.1.2 The temperature test described in 37.1 is to be performed with any automatic temperature-regulating control shunted out of the circuit. The manual-reset limit control shall operate to limit the temperatures of the inner surfaces of the room to not more than 150 °C (302 °F) during the first hour of operation and to not more than 120 °C (248 °F) thereafter.

Exception: When the manual-reset limit control does not operate and the temperatures stabilize at or below 120 °C, the manual-reset limit control is to be caused to operate by simulating abnormal conditions. The simulation of abnormal conditions may consist of increasing the input voltage to the heater, applying thermal insulation to the room, or similar means to increase the inner surface temperatures of the room. When the limit control operates, the temperature limits specified in 42.1.2 shall apply.

42.1.3 The test mentioned in 42.1.2 is to be conducted immediately following the temperature test.

42.1.4 When a motor is connected across a portion of a resistance element, the heater shall not constitute a risk of fire and shall not emit flame or molten metal as the result of an open circuit in that portion of the element that is in parallel with the motor.

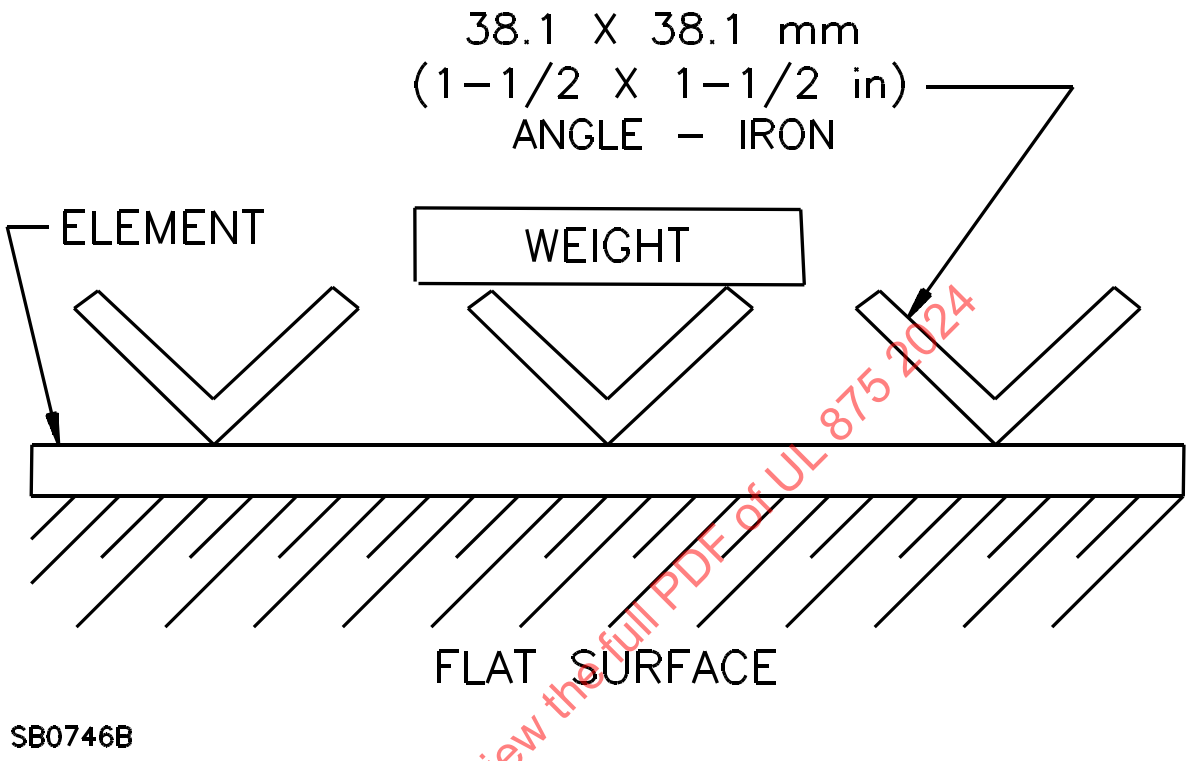
42.2 Mechanical abuse

42.2.1 Any element in a heater constructed so that the rocks used in the unit come in direct contact with the element shall be subjected to the mechanical abuse tests in 42.2.2 and 42.2.3.

42.2.2 The element is to be placed on a flat surface as shown in Figure 42.1 and is to be energized. A downward force of 445 N (100 pounds-force) is to be applied in turn for 15 minutes at each of three locations using a 38.1-mm (1-1/2-inch) angle-iron. Insulation resistance and dielectric withstand tests are then to be conducted in accordance with the Insulation Resistance Test, Section 39, and the Dielectric Voltage-Withstand Test, Section 40.

Figure 42.1

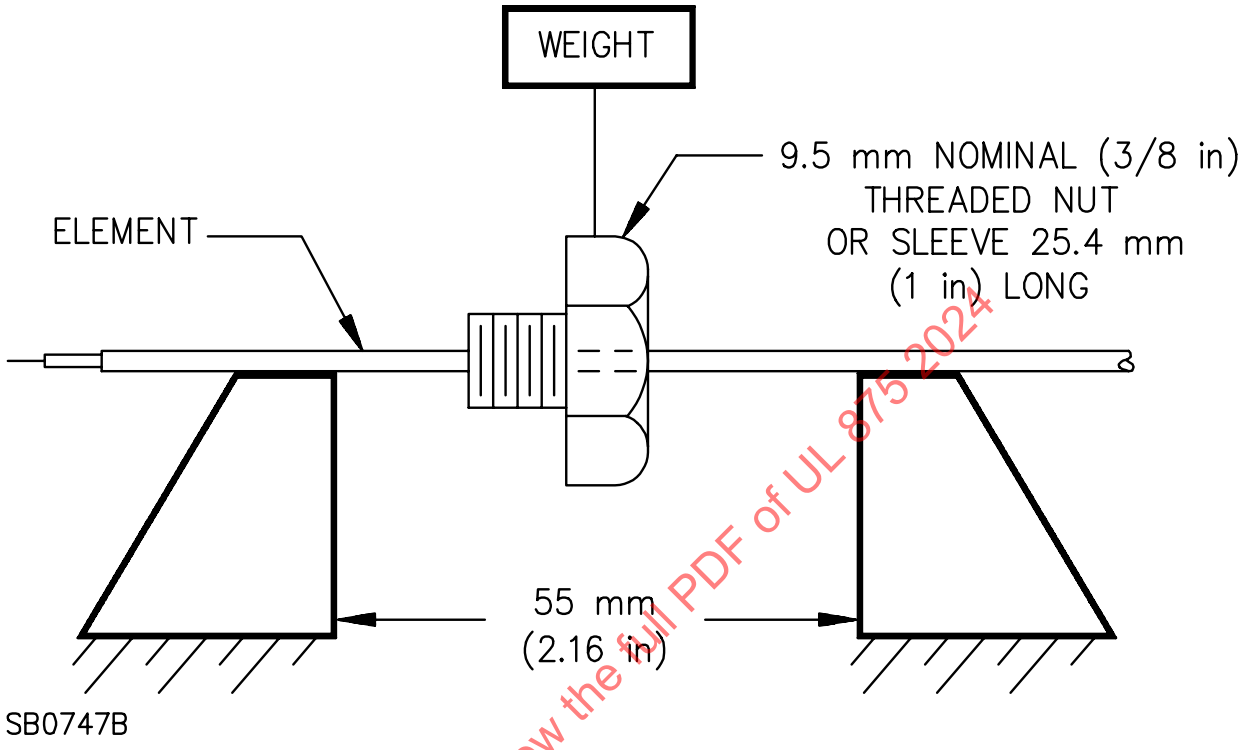
Mechanical Abuse Test Set-Up



42.2.3 A load is to be applied as shown in Figure 42.2, increasing slowly from 0 to 2.45 kN (0 to 550 pounds-force). Permanent deflection after the load is removed shall not exceed 1.6 mm (1/16 inch). Insulation resistance and dielectric withstand tests are then to be conducted in accordance with the Insulation Resistance Test, Section 39, and the Dielectric Voltage-Withstand Test, Section 40.

Figure 42.2

Mechanical Abuse Test Set-Up



42.3 Cheesecloth and towel drape

42.3.1 A heater that is loosely covered with a double layer of cheesecloth backed by a terrycloth towel shall not cause the cloth or towel to glow or flame.

Exception: A ceiling-recessed heater or, as described in 42.3.6, certain types of wall or ceiling surface-mounted heaters, need not be drape tested.

42.3.2 Wherever cheesecloth is mentioned, the cloth is to be bleached cheesecloth 914 mm (36 inches) wide running 28 – 30 m/kg mass (approximately 14 – 15 yards per pound mass), and having what is known to the trade as a count of 32 by 28 – that is, for any square inch, 32 threads in one direction and 28 threads in the other direction (for any square centimeter, 13 threads in one direction and 11 threads in the other direction).

42.3.3 The terrycloth towel is to be a 0.61 by 1.12 m (standard 24 by 44 inch) size, medium grade, 0.56 kg (13 ounce) weight. When additional length is necessary to cover any ventilation openings mentioned in 42.3.4, terrycloth material of equivalent grade and weight may be used.

42.3.4 To determine heater compliance with the requirement in 42.3.1, it is to be operated until constant temperatures are attained and then covered first with a double layer of cheesecloth followed by a terrycloth towel. The cheesecloth and towel are to cover the entire top of the heater, and extend down the sides a sufficient distance to cover any ventilation openings in the enclosure, but not less than half the distance to the bottom of the enclosure. The heater is then to be operated at a voltage in accordance with 37.8 for 7 hours or until the manually resettable cutoff operates. The test is then to be repeated with the cheesecloth and towel in place before the heater is energized.

42.3.5 The test covered in 42.3.1 is to be repeated in the same manner with approximately 50 % of the heater top covered.

42.3.6 A heater intended to be supported by, and mounted away from a wall or ceiling in a horizontal position shall comply with 42.3.1 when tested in the intended position with a double layer of cheesecloth draped over the full length of the heater and hanging down approximately 0.3 m (1 foot) on each side.

42.3.7 In a test to determine compliance with the requirement in 42.3.1, the fan of a combination heater and motor-driven fan is to be operating when the heater is covered with cheesecloth.

42.4 Thermal cutoff

42.4.1 A thermal cutoff, when provided, 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 37.8 and operated as described in 42.4.2.

42.4.2 To determine thermal-cutoff compliance with the requirement in 42.4.1, the heater is to be operated five times, each with a new, separate thermal cutoff in the circuit as described in 42.4.1, and with any other thermally-operated control devices in the heater short-circuited. Each thermal cutoff is required to perform as intended. During the test, the enclosure is to be connected through a 3-ampere fuse to ground, and the thermal cutoff is to be in the ungrounded conductor of the branch circuit supply.

42.5 Stalled fan

42.5.1 A combination heater and motor-driven fan shall not constitute a risk of fire and shall not emit molten metal (other than melted solder) or flame with the fan stalled for a period of 7 hours, or until the manual-reset limit control operates.

42.6 Component breakdown

42.6.1 When tested in accordance with 42.6.2, a simple control of 29.4 having components - such as diodes, resistors, transistors, capacitors, and the like - with a single component fault of short or open, shall not result in any condition as specified in 42.1.1.

Exception No. 1: This test is not required for circuits complying with 30.1.3 or 30.1.4.

Exception No. 2: This test need not be conducted if the components have been investigated and found to have permanence and stability so as to not decrease their limiting capabilities. For the purpose of this test, capacitors connected across the output are not considered likely to open.

42.6.2 A sample is to be connected to the maximum test voltage and operated until ultimate conditions are observed, or for 4 hours if cycling of an automatically reset protector occurs.

43 Motor Switch Overload Test

43.1 A switch or other device that controls a motor, unless intended for the application or interlocked so that it will never break the locked-rotor motor current, shall perform as intended when subjected to an overload test consisting of 50 cycles of operation, making and breaking the locked-rotor current of the motor. The performance is not in compliance when the fuse in the grounding connection opens during the test, and there shall be no burning, pitting, or welding of the contacts that impairs the device's intended function.

43.2 To determine that a switch (or other control device) will perform as intended in the overload test, the heater is to be connected to a grounded supply circuit of rated frequency and of voltage in accordance with 37.8, with the rotor of the motor locked. During the test, exposed dead metal parts of the heater are to be connected to ground through a 3-ampere fuse, and the current-rupturing device, when single-pole, is to be located in an ungrounded conductor of the supply circuit. When the heater is intended for use on direct current, or on direct current as well as alternating current, the test is to be conducted with direct current and exposed dead-metal parts are to be connected so as to be positive with regard to a single-pole, current-rupturing device. The device is to be operated at the rate of 10 cycles per minute.

Exception: A faster rate of operation is not prohibited from being used when agreeable to all concerned.

44 Stability Test

44.1 The stability of a heater intended to stand on the floor shall be such that it will not overturn when subjected to the tests described in 44.2 and 46.1.

44.2 A floor-mounted heater shall not tip over when tilted 15 degrees from its intended, upright freestanding position with all doors, covers, trays, screens, rocks, rock holders, and the like in place, or in the most critical open servicing position. Fastening means are not to be used for this test.

45 Static Loading Test

45.1 Wall- and ceiling-mounted heaters are to be installed in accordance with the manufacturer's instructions and with the mounting hardware supplied by the manufacturer. The mounting means shall be subjected to a load equal to four times the operational weight (heater plus rocks) for one minute. The load is to be applied vertically downward through the center of gravity of the heater. The heater complies with the requirements when there is no:

a) Exposure of uninsulated live parts involving a risk of electric shock as determined in accordance with 7.17;

b) Reduction in electrical spacings;

c) Detachment of the unit from its mounting means; and

d) Condition that presents a risk of injury to persons, as described in 8.1 – 8.5.

45.2 The supports of a floor-mounted heater are to be subjected to a load equal to four times the operational weight (heater plus rocks) for one minute. The load is to be applied vertically downward with the weight equally distributed on the top surface of the heater. The heater complies with the requirements when there is no:

a) Exposure of uninsulated live parts involving a risk of electric shock as determined in accordance with 7.17;

b) Reduction in electrical spacings;

c) Deformation to the extent that the unit becomes unstable; and

d) Condition that presents a risk of injury to persons, as described in 8.1 – 8.5.

46 Strength of Legs Test

46.1 A heater intended to stand on the floor is to be placed on an unfinished plywood floor with the shortest side dimension of the heater parallel to the grain of the floor. Stress is to be applied on the legs by applying a force at the physical center of the side of the heater having the longest horizontal dimension

until the heater moves. During this test all doors, covers, trays, screens, rocks, rock holders, and the like are to be in the most critical open servicing position. Fastening means are not to be used in this test. The heater shall not overturn during this test.

MANUFACTURING AND PRODUCTION-LINE TESTS

47 Dielectric Voltage-Withstand Test

47.1 Each appliance shall withstand without dielectric breakdown, as a routine production-line test, the application of a 40 – 70 hertz potential between the primary wiring, including connected components, and accessible dead-metal parts that are likely to become energized.

47.2 The test potential is to be:

a) 1200 volts for an appliance rated 250 volts or less.

b) 120 % of the sum of 1000 volts plus twice the rated voltage for an appliance rated for more than 250 volts.

47.3 The test potential indicated in 47.2 is to be applied for 1 second.

Exception: When the time of application is increased to 1 minute, the potential may be reduced to five-sixths (83-1/3 %) of the specified values.

47.4 The appliance is to be in a heated or unheated condition for the test.

47.5 The test is to be conducted when the appliance is complete (fully assembled). It is not intended that the appliance be unwired, modified, or disassembled for the test.

Exception No. 1: Parts such as snap covers that interfere with conducting the test are not required to be in place.

Exception No. 2: The test is not prohibited from being performed before final assembly when the test represents that for the completed appliance.

47.6 The test equipment is to include a transformer having an essentially sinusoidal output, a means of indicating the test potential, an audible or visible indicator of dielectric breakdown, and either a manual reset device to restore the equipment after dielectric breakdown or an automatic-reject feature activated by a unit not functioning as intended.

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

47.8 When the output of the test equipment transformer is 500 volt-amperes or greater, the test potential may be indicated by:

a) A voltmeter in the primary circuit or in a tertiary winding circuit,

b) A selector switch marked to indicate the test potential, or

c) In the case of equipment having a single test-potential output, a marking in a readily visible location.

When marking is used without an indicating voltmeter, the equipment is to include a positive means, such as an indicator lamp, to indicate that the manual-reset switch has been reset following a dielectric breakdown.

47.9 Test equipment other than that described in 47.6 – 47.8 is not prohibited from being used when it has been determined to accomplish the intended factory control.

47.10 During the test, the primary switch is to be in the on position, both sides of the primary circuit of the appliance 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: An appliance (resistive, high-impedance winding, and the like) having circuitry not subject to excessive secondary-voltage build-up in case of dielectric breakdown during the test may be tested with a single-pole primary switch, when used, in the off position, or 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.

48 Grounding-Continuity Test

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

48.2 Only a single test is required to be performed when the accessible metal selected is conductively connected by design to all other accessible metal.

48.3 An indicating device such as an ohmmeter, a battery-and-buzzer combination, or the like may be used to determine compliance with the grounding continuity requirement in 48.1.

RATINGS

49 Details

49.1 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 when the heater is intended for use on a polyphase circuit and shall include the frequency when 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, 416, 440 – 480, 550, 575, and 600.

49.2 A stationary heater that includes a motor load of more than 1/20 horsepower (37.3 W output) shall have a dual rating, with each segment of the rating appropriately identified. One segment of the rating shall be that of the motor load in volts and amperes. The other segment shall be the rating of the total load other than the motor load (heater load, lighting load, and the like) in volts and in watts or amperes.

MARKINGS

50 Details

50.1 A heater shall be legibly and permanently marked, where the marking will be plainly visible after installation, with:

a) The manufacturer's name, trade name, or trademark;

b) Date or other dating period of manufacture not exceeding any three consecutive months;

c) The catalog number or the equivalent; and

d) The electrical ratings (in accordance with 49.1 and 49.2) of each circuit to which a supply connection is made.

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

Exception No. 2: The date of manufacture may be abbreviated, in a nationally accepted conventional code or in a code affirmed by the manufacturer.

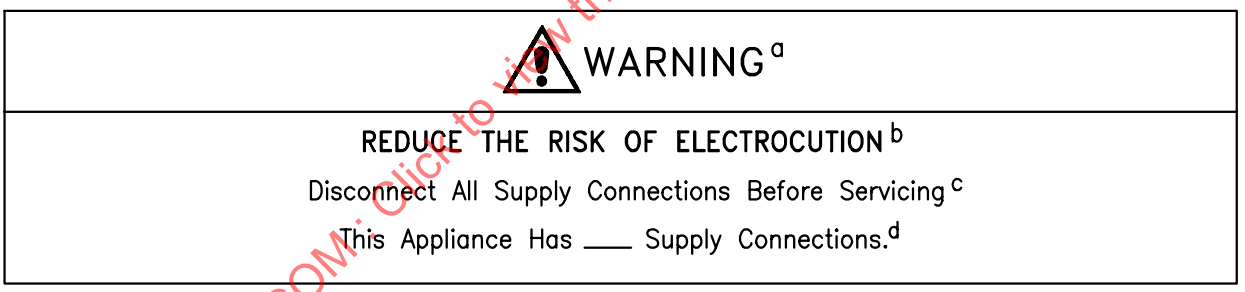
50.2 When a manufacturer produces or assembles equipment at more than one factory, each finished item of equipment shall have a distinctive marking by which it shall be identified as a product of a particular factory.

50.3 A heater intended for use on alternating current or direct current only shall be so marked.

50.4 A heater requiring multiple supply sources shall be marked to indicate the number of supply sources as shown in Figure 50.1. This permanent warning marking shall be located where plainly visible after installation.

Figure 50.1

Supply Source Marking



S4028

Signal Word – Black Lettering/Orange Background

Safety Alert Symbol – Black Triangle/Orange Exclamation Point

Message Panel – Black Lettering/White Background or White Lettering/Black Background

[a] Signal Word letter height shall not be less than 9.5 mm (3/8 inch). No equivalents shall be used for this signal word. A more severe signal word shall not be used.

[b] Message Panel letter height shall not be less than 6.4 mm (1/4 inch).

[c] Letter height shall not be less than 3.2 mm (1/8 inch).

[d] When the number of supply connections is dependent on the installation, the words "This Appliance Has ___ Supply Connections" shall be replaced with "This Appliance May Have Up To ___ Supply Connections." The blank shall be filled in with the maximum number of supply connections to which the unit is capable of being connected.

50.5 When the means for connection of an appliance to the supply source is intended for use only with copper conductors, the appliance shall be marked with the following or equivalent wording: "Use copper

wire only." When the means for connection is intended for use with aluminum as well as copper conductors, the appliance shall be marked with the following or equivalent wording: "Use copper or aluminum wire." This marking shall be independent of any marking on the connectors and may be on a wiring diagram.

50.6 With reference to 50.5, an abbreviation designating copper or aluminum shall be "CU" or "AL."

50.7 Each heating element or unit rated more than 1 ampere that is a part of a heater and is replaceable in the field shall be plainly marked with its electrical ratings in volts and amperes, in volts and watts, or with the manufacturer's name and part number.

50.8 A heating element or unit that is replaceable by hand (such as a plug-in design) or by the use of ordinary hand tools (such as pliers, screwdrivers, and similar tools) is considered to be replaceable in the field.

50.9 A heater that depends upon proper location or position for its intended performance shall be marked (such as "top" and "bottom") to indicate the way it is to be installed or used, unless such position is obvious.

50.10 When the design of a heater requires that disassembly be by means of a tool for the purpose of cleaning or similar servicing by the user (including replacement of a fusible link), and when such disassembly involves the exposure of persons to unintentional contact with any live part that is intended to be enclosed or guarded in use, 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.

50.11 When 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 that device, calling attention to the fact that it should be repositioned in the intended location. The manufacturer's instructions provided with the heater shall call specific attention to this feature.

50.12 When a heater is provided with a replaceable thermal cutoff:

a) The thermal cutoff shall be marked with the name or trademark of the manufacturer of the thermal cutoff and its catalog designation or the equivalent and

b) The heater shall be marked with a statement that a replacement thermal cutoff shall be of the type indicated in (a).

50.13 When field-supplied wiring is required to be brought into the heater room, the heater shall be marked with the following or equivalent statement: "For supply connections, use ___ AWG or larger wires suitable for at least 90 °C (194 °F)." For field-installed conductor other than supply conductors, an equivalent marking shall be used. The AWG size indicated in the marking shall be the size of the conductors used in performing the temperature test. The AWG wire size is not required to be specified when 2.1 mm^2 (14 AWG) wire is used during the test. The statement shall be legible and located so that it is clearly visible during installation and examination of the supply-wiring connections.

50.14 When rocks are essential to enable the heater to comply with any of the requirements in this standard, the heater shall be marked to indicate that the rock compartment is to be filled with rocks and that the heater should not be operated without the rocks in place.

50.15 When a motor in a heater is provided with leads or terminals separate from the supply leads or terminals of the heater, instructions shall be provided for connection and overcurrent protection of the motor.

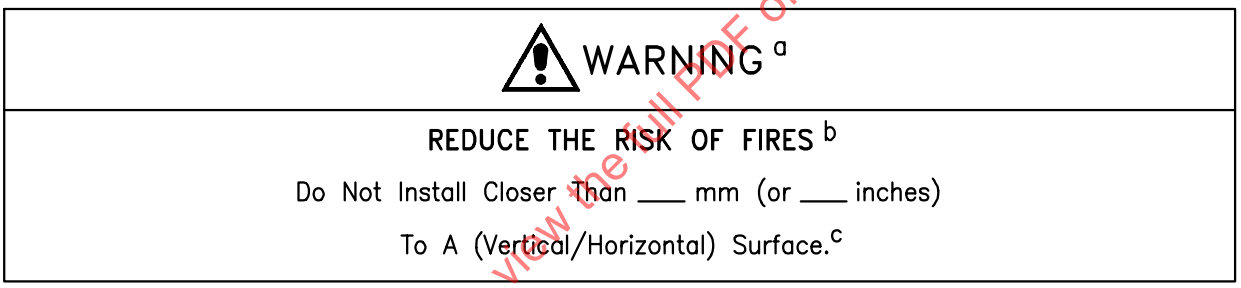
50.16 An inherently thermally-protected motor provided as part of a heater shall be marked with the following: "Thermally protected." An impedance protected motor provided as part of a heater shall be marked with the following: "Impedance protected."

50.17 When a motor greater than 1/8 horsepower (93.25 W output) is used in a heater, the marking on the heater shall specify the rating of the motor in volts and amperes and the additional load in volts and watts or amperes.

50.18 When a minimum spacing from the heater is required to reduce the risk of a temperature on adjacent combustible surfaces higher than 120 °C (248 °F) during the first hour of intended operation and 90 °C (194 °F) following the first hour, or 150 °C (302 °F) during the first hour of operation with the temperature-regulating thermostat short-circuited and 120 °C following the first hour, the heater shall be marked as specified in Figure 50.2. The value of the spacing to be used in the statement shall not be less than that required to reduce the risk of attainment of such temperatures on adjacent surfaces.

Figure 50.2

Minimum Spacing Marking



S4029A

Signal Word – Black Lettering/Orange Background

Safety Alert Symbol – Black Triangle/Orange Exclamation Point

Message Panel – Black Lettering/White Background or White Lettering/Black Background

[a] Signal Word letter height shall not be less than 4.8 mm (3/16 inch). No equivalents shall be used for this signal word. A more severe signal word shall not be used.

[b] Message Panel letter height shall not be less than 3.2 mm (1/8 inch).

[c] Letter height shall not be less than 1.6 mm (1/16 inch).

50.19 A heater shall be provided with a permanent marking indicating the minimum and maximum size rooms in which it is intended to be installed. The sizes shall be specified in terms of the floor length and width, or floor area, and the interior wall height.

50.20 A wall-mounted heater shall be marked to indicate the minimum distance to be maintained between the top of the heater and the ceiling of the room.

50.21 The intended location of controls not integral with the heater, and which are to be installed in the field, shall be specified by a marking on the heater.

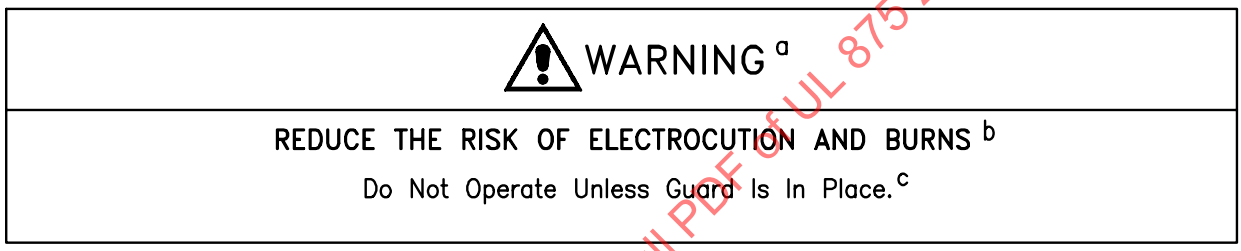
50.22 Unless the intended wiring of the heater is otherwise made known, the wiring circuit diagram required in 52.1(f) shall be on the heater or control panel.

50.23 The markings required in 50.18, 50.19, and 50.21 shall be legible and located so that they will be clearly visible during installation of the heater and during examination of the supply wiring connections.

50.24 When the guard of a heater is readily removable (for example, when it is intended to be removed for shipping and storage), the heater shall be plainly and legibly marked, in a location where the marking is readily visible after the heater has been installed as intended, with a warning that it shall not be operated unless the guard is in place. See Figure 50.3.

Figure 50.3

Heater Guard Marking



S4030

Signal Word – Black Lettering/Orange Background

Safety Alert Symbol – Black Triangle/Orange Exclamation Point

Message Panel – Black Lettering/White Background or White Lettering/Black Background

[a] Signal Word letter height shall not be less than 9.5 mm (3/8 inch). No equivalents shall be used for this signal word. A more severe signal word shall not be used.

[b] Message Panel letter height shall not be less than 6.4 mm (1/4 inch).

[c] Letter height shall not be less than 3.2 mm (1/8 inch).

50.25 When a contactor or control panel is necessary for use with a heater, the heater shall be marked to indicate the identity of the device required.

50.26 Each heater shall be provided with a metal plate or pressure-sensitive label marked permanently with the warning marking specified in Figure 50.4. A metal plate, when provided, shall be accompanied with appropriate screws or nails. Instructions for mounting the plate or label to the door of the room or on a wall adjacent to the door or on the product shall also be provided.

Figure 50.4

Hyperthermia Warning Marking

WARNING [a]
REDUCE THE RISK OF OVERHEATING [b] 1. Exit immediately if uncomfortable, dizzy, or sleepy. Staying too long in a heated area is capable of causing overheating.[c] 2. Supervise children at all times.[c] 3. Check with a doctor before use if pregnant, in poor health, or under medical care.[c] 4. Breathing heated air in conjunction with consumption of alcohol, drugs, or medication is capable of causing unconsciousness.[c]

S4031

Signal Word – Black Lettering/Orange Background

Safety Alert Symbol – Black Triangle/Orange Exclamation Point

Message Panel – Black Lettering/White Background or White Lettering/Black Background

[a] Signal Word letter height shall not be less than 12.7 mm (1/2 inch). No equivalents shall be used for this signal word. A more severe signal word shall not be used.

[b] Message Panel letter height shall not be less than 9.5 mm (3/8 inch).

[c] Letter height shall not be less than 6.4 mm (1/4 inch).

50.27 An additional metal plate bearing the permanent marking specified in Figure 50.5 shall be provided with each heater. The plate shall be provided with a means for mounting on the wall adjacent to the heater.

Exception: A ceiling-recessed heater or a floor- or wall-mounted heater that is constructed such that items are not capable of being placed on it is not required to be provided with this marking.

Figure 50.5

Fire Warning Marking

S4032

Signal Word – Black Lettering/Yellow Background

Safety Alert Symbol – Black Triangle/Yellow Exclamation Point

Message Panel – Black Lettering/White Background or White Lettering/Black Background

[a] Signal Word letter height shall not be less than 9.5 mm (3/8 inch). No equivalents shall be used for this signal word. A more severe signal word shall not be used.

[b] Message Panel letter height shall not be less than 6.4 mm (1/4 inch).

[c] Letter height shall not be less than 3.2 mm (1/8 inch).

50.28 A heater intended for household use shall be marked "For household use only" or the equivalent, as described in 52.1(a)(1) and 56.1.

51 Permanence of Markings

51.1 The markings required in Markings (Details), Section 50, and Warning Marking, Section 56, shall be located on the enclosure or on a part that would either require tools for removal or, when removed, would impair the operation of the appliance.

51.2 A marking that is required to be permanent shall be:

a) Etched, molded, die-stamped, or paint-stenciled on the enclosure;

b) Stamped or etched on permanently-secured metal; or

c) Indelibly stamped lettering on pressure-sensitive labels secured by adhesive.

51.3 Pressure-sensitive labels secured by adhesive shall comply with UL 969.

51.4 Ordinary usage (such as handling and storage) of the appliance shall be considered when determining the permanence of a marking.

INSTALLATION INSTRUCTIONS

52 Details

52.1 Installation instructions shall be provided with each heater and shall include the following:

a) Reference to the warning marking provided with the heater, indicating the importance of attaching the marking, using the screws or nails provided in the intended location, at eye level, as follows:

1) The marking required in 50.26 shall be specified for location on the outside of the door.

Exception: When the heater is marked for household use as specified in 50.28, the warning marking location is capable of being specified for the inside of the door.

2) The marking required in 50.27 shall be specified for location on the interior wall above the heater.

b) Materials and thickness recommendations for construction of the room, in which the wood and glass fiber thicknesses for the walls and ceiling are not less than those used when the heater was tested in accordance with 37.12.

c) Minimum and maximum dimensions of the room in which the heater may be installed, stated in terms of the floor length and width, or floor area, and the interior wall height.

d) Directions for securely mounting the heater with the hardware provided.

e) Minimum spacings of the heater from adjacent surfaces.

f) Wiring instructions including circuit diagram, size and type of supply wiring, and specifications for the contactors or control panel to be used with the heater, when provided.

g) In the case of a room temperature control that is not an integral part of the heater and that is to be installed during assembly of the room in the field, the instructions shall clearly specify the identity of the control (manufacturer's name and catalog number, or equivalent), its correct location in the room, and the means for providing resistance to damage.

h) The type, location, and method of installation of the guard or fence specified in the Exception to 8.5 when such guard or fence is required.

i) When a timed-cutoff switch is not provided as an integral part of the heater or control panel in accordance with 26.9 – 26.18, the instructions shall include the following statements or the equivalent:

"When this heater is not installed for use with an attendant, a timed-cutoff switch must be connected in the input circuit to disconnect all ungrounded conductors of the heater circuit from the supply source at the end of 1 hour of operation.

The timed-cutoff switch shall be located outside the heater room, or mounted to a wall or door inside the heater room.

The time feature of the switch must not lend itself to being overridden."

The type (manufacturer's name and catalog number, or equivalent), location, and method of installation of the timer shall also be included.

Exception: This marking shall be provided on a metal plate or pressure-sensitive label which is secured to the heater as an alternative to providing it in the installation manual.