UL 2021

STANDARD FOR SAFETY

Fixed and Location-Dedicated Electric Room Heaters

UL Standard for Safety for Fixed and Location-Dedicated Electric Room Heaters, UL 2021

Fourth Edition, Dated September 30, 2015

Summary of Topics

This revision of ANSI/UL 2021 dated February 2, 2021 includes replacing the reference to the Standard for Power Conversion Equipment, UL 508C, with reference to the Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1; 3.3.4.1 and 21.4

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal (s) on this subject dated November 6, 2020.

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Standard for Fixed and Location-Dedicated Electric Room Heaters

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Fourth Edition

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This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through February 2, 2021.

The most recent designation of ANSI/UL 2021 as an American National Standard (ANSI) occurred on February 2, 2021 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 UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover fixed and location-dedicated electric room heating equipment rated 600 volts or less to be employed in ordinary locations in accordance with the National Electrical Code, ANSI/NFPA 70.

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

2 Glossary

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

2.2 APPLIANCE COUPLER – A single-outlet, female contact device for attachment to a flexible cord as part of a detachable power-supply cord to be connected to an appliance inlet (motor attachment plug).

2.3 APPLIANCE INLET (Motor Attachment Plug) – A male contact device mounted on an end product appliance to provide an integral blade configuration for the connection of an appliance coupler or cord connector.

2.4 APPLIANCE (FLATIRON) PLUG – An appliance coupler type of device having a cord guard and a slot configuration specified for use with heating or cooking appliances.

2.5 CEILING SURFACE-MOUNTED HEATER – A heater that is permanently attached and mounted directly to a ceiling surface in such a manner that tools are necessary for its removal.

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

a) Rated 2 kilowatts or greater and marked as a commercial/industrial heater in accordance with 59.16,

b) Rated greater than 250 volts,

c) A polyphase heater, or

d) Rated greater than 6 kilowatts.

2.7 COMPONENT – A device or fabricated part of the appliance covered by the scope of a safety standard dedicated to the purpose. When incorporated in an appliance, equipment otherwise typically field installed (e. g. luminaire) is considered to be a component. Unless otherwise specified, materials that compose a device or fabricated part, such as thermoplastic or copper, are not considered components.

2.8 CORD CONNECTOR – A female contact device wired on flexible cord for use as an extension from an outlet to make a detachable electrical connection to an attachment plug or, as an appliance coupler, to an equipment inlet.

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

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

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

2.12 LOCATION-DEDICATED HEATER – A cord-connected heater that is normally placed in one location for usage such as cord-connected wall- or ceiling-mounted heater, or freestanding cord-connected heater that exceeds the weight or dimension limitations, or both of a movable heater.

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

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

a) Regulating – Functions only to regulate the temperature of the heater under intended conditions of use, and whose malfunction would not result in a risk of fire.

b) Limiting – Functions only under conditions that produce abnormal temperatures. The malfunction of such a device will result in a risk of fire.

c) Auxiliary – Thermostatic device other than of the regulating or limiting type.

d) Operating Control – A control intended to start or regulate the heater during normal operation. An example would be a temperature-regulating control. An operating control could provide Type 1 or Type 2 action. (See definitions 2.15 – 2.18).

e) Protective Control – A control intended to reduce the risk of electric shock, fire, or injury to persons during abnormal operation of the heater. An example would be a temperature limiting control. A protective control always provides Type 2 action. (See definitions 2.15 – 2.18).

2.15 TYPE 1 ACTION – Automatic action for which the manufacturing deviation and the drift of its operating value, operating time, or operating sequence have not been declared and tested to the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

2.16 TYPE 2 ACTION – Automatic action for which the manufacturing deviation and the drift of its operating value, operating time, or operating sequence have been declared and tested to the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

2.17 TYPE 2.H ACTION – 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.

2.18 TYPE 2.J ACTION – So designed that the contacts cannot be prevented from opening, and the control is not permitted to function as an automatic reset device if the reset means is held in the reset position. The control shall not reset automatically at any temperature above -35 °C.

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

2.20 WALL (OR CEILING) HUNG HEATER – A cord-connected heater weighing 50 pounds (22.6 kg) or less that is attached to the wall (or ceiling) in such a manner that it can be removed without the use of tools.

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

3 Components

3.1 General

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

a) Comply with the requirements for that component as indicated in 3.2 – 3.10;

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;

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

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 that complies with a UL component standard other than those specified in 3.2 – 3.10 is acceptable if:

a) The component also complies with the applicable component standard specified in 3.2 – 3.10; or

b) The component standard:

1) Is compatible with the ampacity and overcurrent protection requirements in the National Electrical Code, ANSI/NFPA 70, where applicable;

2) Considers long-term thermal properties of polymeric insulating materials in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, 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.

3.1.2 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.

3.1.3 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 UL standard(s) that cover devices that provide those functions.

Exception: Where these other functions are not required for the application and not identified as part of markings, instructions, or packaging for the appliance, the additional component standard(s) need not be applied.

3.1.4 A component not anticipated by the requirements of this end product standard, not specifically covered by the component standards in 3.2 – 3.10, and that involves a risk of fire, electric shock, or injury to persons, shall be additionally investigated in accordance with the applicable UL standard, and shall comply with 3.1.1 (b) – (e).

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

3.2 Attachment plugs, receptacles, connectors, and terminals

3.2.1 Attachment plugs, receptacles, appliance couplers, appliance inlets (motor attachment plugs), and appliance (flatiron) plugs, shall comply with the Standard for Attachment Plugs and Receptacles, UL 498. See 3.2.6.

Exception: Attachment plugs and appliance couplers integral to cord sets or power supply cords that are investigated in accordance with the Standard for Cord Sets and Power Supply Cords, UL 817 are not required to comply with UL 498.

3.2.2 Female devices (such as 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.

3.2.3 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 the Standard for Insulated Multi-Pole Splicing Wire Connectors, UL 2459.

3.2.4 Equipment wiring terminals for use with all alloys of copper, aluminum, or copper-clad aluminum conductors, shall comply with the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

3.2.5 Terminal blocks shall comply with the Standard for Terminal Blocks, UL 1059, and, if applicable, be suitably rated for field wiring.

3.2.6 Female devices (such as 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.

3.3 Controls

3.3.1 General

3.3.1.1 Auxiliary controls shall be evaluated in accordance with the applicable requirements of this end product standard unless otherwise specified; see 3.3.1.7.

3.3.1.2 Operating (regulating) controls shall be evaluated in accordance with the applicable component standard requirements specified in 3.3.2 – 3.3.6, if applicable, unless otherwise specified in this end product standard ; see 3.3.1.7.

3.3.1.3 Operating controls that rely upon software for the normal operation of the end product where deviation or drift of the control may result in a risk of fire, electric shock, or injury to persons, such as a speed control unexpectedly changing its output, shall comply with one of the following:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, and the Standard for Software in Programmable Components, UL 1998; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

3.3.1.4 Protective (limiting) controls shall be evaluated in accordance with the applicable component standard requirements specified in 3.3.2 – 3.3.6, unless otherwise specified in this end product standard.

3.3.1.5 Solid-state protective controls that do not rely upon software as a protective component shall comply with one of the following:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, except the Controls Using Software requirements, Clause H 11.12.

3.3.1.6 Solid-state protective controls that rely upon software as a protective component shall comply with one of the following:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, and the Standard for Software in Programmable Components, UL 1998; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

3.3.1.7 An electronic, auxiliary or operating control (e.g. a non-protective control), the failure of which would not increase the risk of fire, electric shock, or injury to persons, need only be subjected to the applicable requirements of this end product standard.

3.3.2 Electromechanical and electronic controls

3.3.2.1 A control, other than as specified in 3.3.3 – 3.3.6, shall comply with one of the following:

a) The Standard for Solid-State Controls for Appliances, UL 244A;

b) The Standard for Temperature-Indicating and -Regulating Equipment, UL 873; or

c) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

3.3.3 Liquid level controls

3.3.3.1 A liquid level control shall comply with one of the following:

a) The Standard for Solid-State Controls for Appliances, UL 244A;

b) The Standard for Temperature-Indicating and -Regulating Equipment, UL 873;

c) The Standard for Industrial Control Equipment, UL 508; or

d) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and

Deleted

2) The Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Air Flow, Water Flow and Water Level Sensing Controls, UL 60730-2-15.

3.3.4 Motor and speed controls

3.3.4.1 A control used to start, stop, regulate or control the speed of a motor shall comply with one of the following:

a) The Standard for Solid-State Controls for Appliances, UL 244A;

b) The Standard for Temperature-Indicating and -Regulating Equipment, UL 873;

c) The Standard for Industrial Control Equipment, UL 508;

d) The Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1; or

e) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

3.3.5 Pressure controls

3.3.5.1 A pressure control shall comply with one of the following:

a) The Standard for Temperature-Indicating and -Regulating Equipment, UL 873;

b) The Standard for Industrial Control Equipment, UL 508;

c) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements, UL 60730-2-6.

3.3.6 Timer controls

3.3.6.1 A timer control shall comply with one of the following:

a) The Standard for Solid-State Controls for Appliances, UL 244A; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Timers and Time Switches, UL 60730-2-7.

3.4 Cords, cables, and internal wiring

3.4.1 A cord set or power supply cord shall comply with the Standard for Cord Sets and Power Supply Cords, UL 817.

3.4.2 Flexible cords and cables shall comply with the Standard for Flexible Cords and Cables, UL 62. Flexible cord and cables are considered to comply with this requirement when pre-assembled in a cord set or power supply cord complying with the Standard for Cord Sets and Power Supply Cords, UL 817.

3.4.3 Internal wiring composed of insulated conductors shall comply with the Standard for Appliance Wiring Material, UL 758.

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

a) The Standard for Thermoset-Insulated Wires and Cables, UL 44;

b) The Standard for Thermoplastic-Insulated Wires and Cables, UL 83;

c) The applicable UL standard(s) for other insulated conductor types specified in Chapter 3, Wiring Methods and Materials, of the National Electrical Code, ANSI/NFPA 70.

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, electric shock or injury to persons need not comply with UL 758.

3.5 Film-coated wire (magnet wire)

3.5.1 The component requirements for film coated wire and Class 105 (A) insulation systems are not specified.

3.5.2 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 the Standard for Systems of Insulating Materials – General, UL 1446.

3.6 Insulation systems

3.6.1 Materials used in a Class 105 (A) insulation system shall comply with 19.2.

3.6.2 Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with the Standard for Systems of Insulating Materials – General, UL 1446.

3.6.3 All insulation systems employing integral ground insulation shall comply with the requirements specified in the Standard for Systems of Insulating Materials – General, UL 1446.

3.7 Printed wiring boards

3.7.1 Printed wiring boards, including the coatings, shall comply with the Standard for Printed Wiring Boards, 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.

3.7.2 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 Electrical Insulation, Section 14 of this end product standard.

3.7.3 Unless otherwise specified, the flammability class and temperature rating shall be that as specified in Electrical Insulation, Section 17 of this end product standard.

3.8 Semiconductors and small electronic components

3.8.1 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with the Standard for Optical Isolators, UL 1577. The Dielectric Voltage Withstand Tests required by UL 1577 shall be conducted applying the requirements of the Dielectric Voltage Withstand Test, Section 46, of this end product standard.

3.8.2 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 the Standard for Optical Isolators, UL 1577. The Dielectric Voltage Withstand Tests required by UL 1577 shall be conducted applying the requirements in Dielectric Voltage Withstand Test, Section 46 of this end product standard.

3.8.3 Except as specified in 3.8.4, 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.

3.8.4 Where an electronic component is determined to be a critical component during the Abnormal Operation Tests, Section 32, one of the following standards shall be applied:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, and as applicable, the Standard for Software in Programmable Components, UL 1998 for controls that rely upon software as a protective component; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

3.8.5 A critical component, as specified in 3.8.4, is a component that performs one or more safety-related functions whose failure results in a condition, such as the risk of fire, electric shock, or injury to persons, in the end product application.

3.8.6 A critical component as specified in 3.8.4, may also be identified using a failure-mode and effect analysis (FMEA) in accordance with the Failure-Mode and Effect Analysis (FMEA) requirements in the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991.

3.8.7 Portions of a circuit comprised of a microcontroller or other programmable device that performs a back-up, limiting, or other safety function intended to reduce the risk of fire, electric shock, or injury to persons shall comply with the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, Annex H.

3.9 Supplemental insulation, insulating bushings, and assembly aids

3.9.1 The requirements for supplemental insulation (e. g. tape, sleeving or tubing) are not specified unless the insulation or device is required to comply with 15.3 or a performance requirement of this end product standard. In such cases, the insulation shall comply with the following applicable standards:

a) Insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510;

b) Sleeving shall comply with the Standard for Coated Electrical Sleeving, UL 1441; or

c) Tubing shall comply with the Standard for Extruded Insulating Tubing, UL 224.

3.9.2 Wire positioning devices shall comply with the requirements in Electrical Insulation, Section 17. A device that complies with the Standard for Positioning Devices, UL 1565, is considered to comply with this requirement.

3.9.3 Insulating bushings that comply with the requirements in General, Section 3.1, of this end product standard, and the Standard for Insulating Bushings, UL 635 are considered to comply with the requirements of this end product standard. Tests specified in this end product standard (e.g. Strain Relief Test, Section 13.3) may still need to be performed to confirm the combination of the insulating bushing and the supporting part comply with the intent of the requirements.

3.10 Switches

3.10.1 Switches shall comply with one of the following:

a) *Deleted*

b) The Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1;

c) The Standard for General-Use Snap Switches, UL 20; or

d) The Standard for Nonindustrial Photoelectric Switches for Lighting Control, UL 773A.

Exception: Switching devices that comply with the applicable UL standards 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 with this requirement.

3.10.2 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) The Standard for Clock-Operated Switches, UL 917; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Timers and Time Switches, UL 60730-2-7.

3.10.3 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 one of the following:

a) The Standard for Solid-State Controls for Appliances, UL 244A; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Timers and Time Switches, UL 60730-2-7.

3.10.4 A timer or time switch, incorporating electronic timing circuits or switching circuits, with or without separable contacts, that functions as a protective control, shall comply with the requirements for a protective control; see 3.3.1.3.

3.11 Transformers

3.11.1 General-purpose transformers shall comply with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1; and the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2.

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

Exception No. 2: A transformer that complies with the Standard for Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411, and that is used in a circuit involving an audio or video component complies with the intent of this requirement.

4 Units of Measurement

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

4.2 Unless indicated otherwise, all voltage and current values mentioned in this Standard are rms.

5 References

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

6 General

6.1 A location-dedicated heater that is considered likely to be operated as a movable heater shall also comply with the requirements for movable heaters.

6.2 If the operation of a heater involves the generation and confining under pressure of steam or other gas, consideration is to be given to the possibility of risk of explosion incident to such operation. This applies in the case of an appliance having immersed electrodes, if the electrolysis of water may result in the accumulation of oxygen and hydrogen. The appliance is not acceptable unless its strength is such that it will withstand any risk of explosion that may be involved.

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7 Enclosure

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

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

a) Mechanical strength,

b) Resistance to impact,

c) Moisture-absorption properties,

d) Flammability,

e) Resistance to corrosion, and

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

For the requirements for a polymeric enclosure or part of an enclosure of a polymeric material, see Polymeric Materials, Section 9.

7.3 The enclosure of a heater intended for permanent installation shall be provided with means for mounting in the intended manner. Any fittings – such as brackets, hangers, or the like – necessary for mounting shall be furnished with the heater.

7.4 The enclosure of a heater shall prevent molten metal, burning insulation, flaming particles, or the like from falling on combustible materials, including the surface upon which the heater is supported. See 7.7.

7.5 The requirement in 7.4 necessitates use of a barrier of noncombustible material:

a) Under a motor unless:

1) The structural parts of the motor or of the heater provide the equivalent of such a barrier.

2) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the heater if the motor is energized under each of the following fault conditions:

i) Open main winding,

ii) Open starting winding, and

iii) Starting switch short-circuited, or

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

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

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

7.6 A heater intended for installation in a dropped ceiling shall be provided with adequate means for being mounted on and secured to adjacent T-bars. See also 59.31.

7.7 A heater intended for ceiling or high-wall mounting may be exempted from the requirements in 7.4. The acceptability of the enclosure of such a heater will be judged on the basis of its design and construction.

7.8 Except as indicated in 7.9, if openings for ventilation are provided in the enclosure of a heater or in an externally mounted component intended for permanent connection to the power supply, they shall be so located that they will not vent into concealed spaces of a building structure such as into false-ceiling space, into hollow spaces in the wall, or the like when the appliance is installed as intended.

7.9 The requirement in 7.8 does not apply to an opening for a mounting screw or nail if:

a) No such opening has a dimension more than 17/64 inch (6.75 mm) or an area more than 0.055 square inch (35.5 mm^2), and

b) There are no more than four holes in the rear of the enclosure and no more than two holes in each of the other four sides of the enclosure.

7.10 Other openings for a manufacturing operation, such as for paint drainage, for locating the part during a stamping or similar production operation, may be provided, but they shall also comply with 7.9. Lanced openings, tabs, or the like, if the displaced metal is retained, are acceptable if the openings are substantially baffled by the displaced metal or closed up by positively retained mounting brackets, springs used to support grilles, and the like.

7.11 Except as noted in 7.12, an opening for ventilation in the enclosure, other than in the bottom, of a heater and an opening associated with the dissipation of heated air from the element shall be provided with one or more baffles that will prevent the emission of flame, molten metal, burning insulation, or the like from the heater.

7.12 In a compartment other than one that houses an overload or overcurrent protective device, the baffles mentioned in 7.11 may be omitted if:

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

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

7.13 Cast- and sheet-metal portions of the enclosure shall not be thinner than indicated in Table 7.1 unless the enclosure is found to be acceptable when judged under considerations such as are mentioned in 7.2 and 7.14.

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

7.15 Sheet metal to which a wiring system is to be connected in the field shall have an average thickness not less than 0.032 inch (0.81 mm) if uncoated steel, not less than 0.034 inch (0.86 mm) if galvanized steel, and no less than 0.045 inch (1.14 mm) if nonferrous.

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

a) 0.032 inch (0.81 mm) if of ferrous metal,

b) 0.045 inch (1.14 mm) if of nonferrous metal, and

c) 0.10 inch (2.5 mm) if of insulating material, except that an enclosure of insulating material may be of lesser thickness if formed or reinforced to provide physical strength. The insulating material shall be noncombustible.

7.17 An electrical part of a heater shall be so located or enclosed that protection against unintentional contact with uninsulated live parts will be provided, except that this requirement does not apply to the radiating portion of an open-wire element and the connections immediately adjacent to the radiating element. See 7.18, 28.6, 28.15, and 59.25. Insulated motor brush caps do not require additional enclosures.

7.18 The requirement in 7.17 does not apply to the radiating sheath of an isolated metal-clad element in a heater having provision for grounding the enclosure, although such sheath is considered to be a bare live part when spacings are being measured.

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

a) The proximity of uninsulated live parts (as determined by applying 7.17, 7.18, 7.20, 7.26, and 7.33) and

b) The possibility of the emission of burning insulation, molten metal, and the like through the opening (as determined by applying 7.4 – 7.12).

Table 7.1
Minimum acceptable thicknesses of enclosure material

Metal	At small, flat, unreinforced surfaces and at surfaces that are reinforced by curving, ribbing and the like (or are otherwise of a shape and/or size) to provide mechanical strength		At relatively large unreinforced flat surfaces	
	inches	millimeters	inches	millimeters
Die-cast	3/64	1.2	5.64	2.0
Cast malleable iron	1/16	1.6	3/32	2.4
Other cast metal	3/32	2.4	1/8	3.2
Uncoated sheet steel	0.026[a]	0.66[a]	–	–
Galvanized sheet steel	0.029[a]	0.74[a]	–	–
Nonferrous sheet metal	0.036[a]	0.91[a]	–	–

[a] Thinner sheet metal may be employed if found to be acceptable when the enclosure is judged under considerations such as those mentioned in 7.2 and 7.14.

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

a) For an opening that has a minor dimension (see 7.24) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 7.3.

b) For an opening that has a minor dimension of 1 inch or more, such a part or wire shall be spaced from the opening as specified in Table 7.2.

Exception: An integral enclosure of a motor need not comply with these requirements if it complies with the requirements in 7.21.

7.21 With respect to a part or wire as mentioned in 7.20, in an integral enclosure of a motor as mentioned in the Exception to 7.20:

a) An opening that has a minor dimension (see 7.24) less than 3/4 inch (19.1 mm) is acceptable if:

1) Film-coated wire cannot be contacted by the probe illustrated in Figure 7.2;

2) In a directly accessible motor (see 7.25), an uninsulated live part cannot be contacted by the probe illustrated in Figure 7.4; or

3) In an indirectly accessible motor (see 7.25), an uninsulated live part cannot be contacted by the probe illustrated in Figure 7.1.

b) An opening that has a minor dimension of 3/4 inch (19.1 mm) or more is acceptable if a part or wire is spaced from the opening as specified in Table 7.2.

Table 7.2
Minimum acceptable distance from an opening to a part that may involve a risk of electric shock

Minor dimension[a] of opening		Minimum distance from opening to part	
inches[b]	(mm)[b]	inches[b]	(mm)[b]
3/4[c]	(19.1)	4-1/2	(114.0)
1[c]	(25.4)	6-1/2	(165.0)
1-1/4	(31.8)	7-1/2	(190.0)
1-1/2	(38.1)	12-1/2	(318.0)
1-7/8	(47.6)	15-1/2	(394.0)
2-1/8	(54.0)	17-1/2	(444.0)
d		30	(762.0)

[a] See 7.24.

[b] Between 3/4 inch (19.1 mm) and 2-1/8 inches (54.0 mm), interpolation is to be used to determine a value between values specified in the table.

[c] Any dimension less than 1 inch (25.4 mm) applies to a motor only.

[d] More than 2-1/8 (54.0 mm) inches, but not more than 6 inches (152.0 mm).

7.22 The probes mentioned in 7.20 and 7.21 and illustrated in Figure 7.1, Figure 7.2, Figure 7.3, and Figure 7.4 shall be applied to any depth that the opening will permit; and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the enclosure. The probes illustrated in Figure 7.3 and Figure 7.4 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

Figure 7.1

Probe for uninsulated live parts

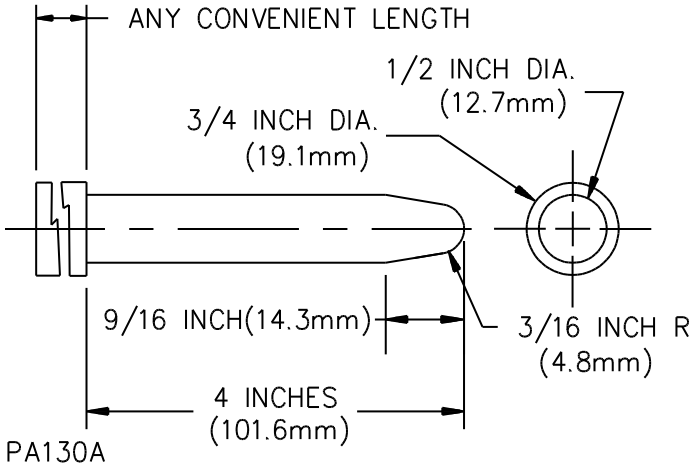
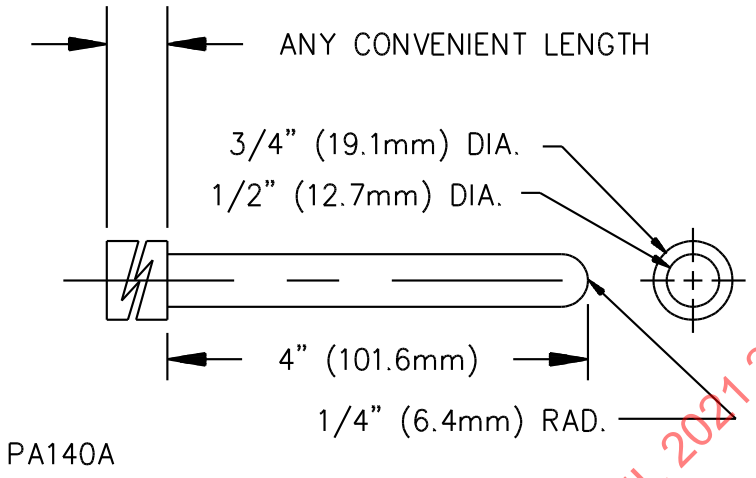


Figure 7.2

Probe for film-coated wire



7.23 The probes mentioned in 7.22 and 7.24 shall be used as measuring instruments to judge the accessibility provided by an opening, and not as instruments to judge the strength of a material; they shall be applied with the minimum force necessary to determine accessibility.

7.24 With reference to the requirements in 7.20 and 7.21, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening.

7.25 With reference to the requirements in 7.21, an indirectly accessible motor is a motor:

a) That is accessible only by opening or removing a part of the outer enclosure, such as a guard or panel, that can be opened or removed without using a tool, or

b) That is located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted.

A motor in a ceiling insert heater or in a heater marked in accordance with 59.23 is considered to be an indirectly accessible motor. A directly accessible motor is a motor:

c) That can be contacted without opening or removing any part or

d) That is located so as to be accessible to contact.

Figure 7.3

Articulate probe with web stop

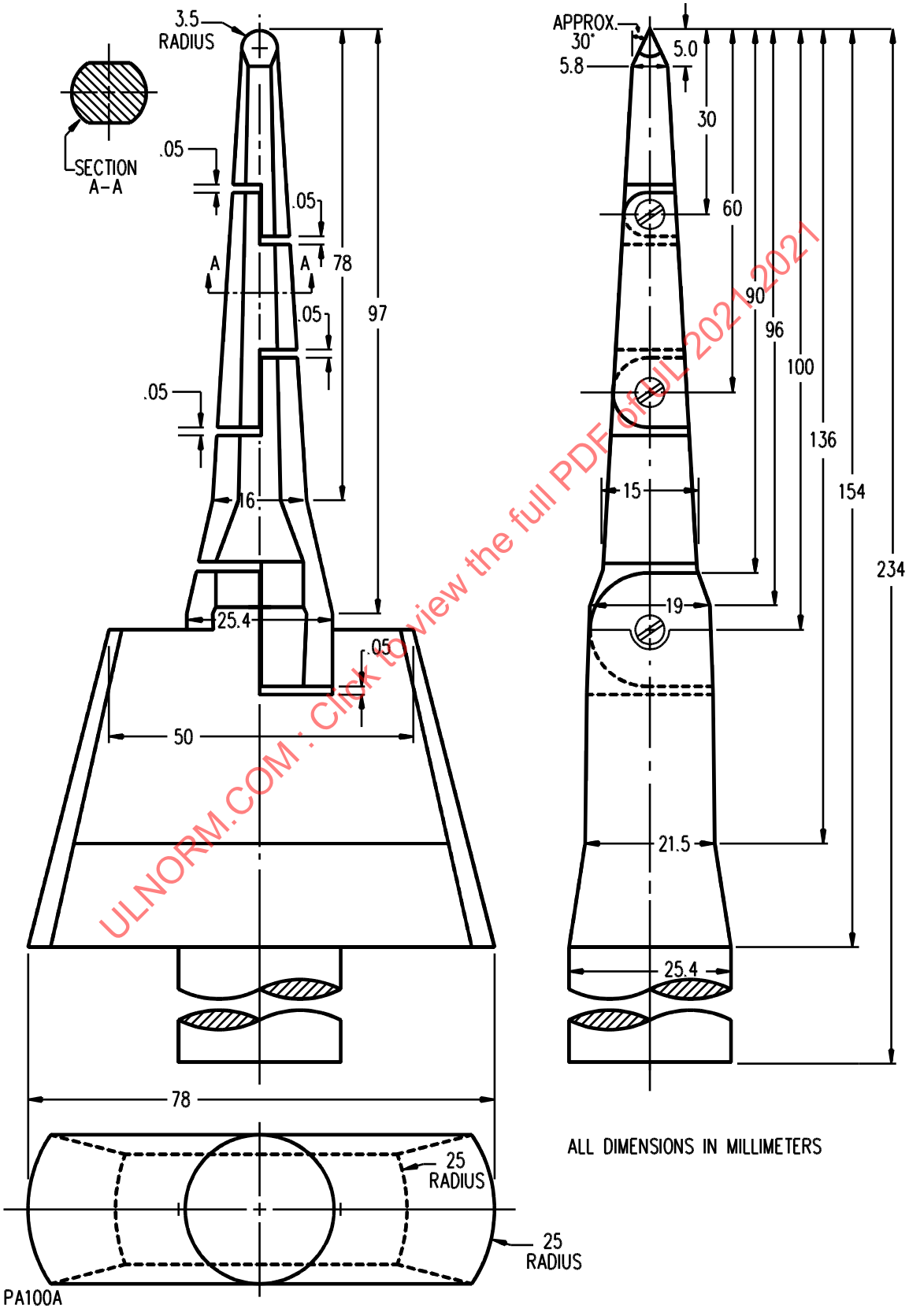
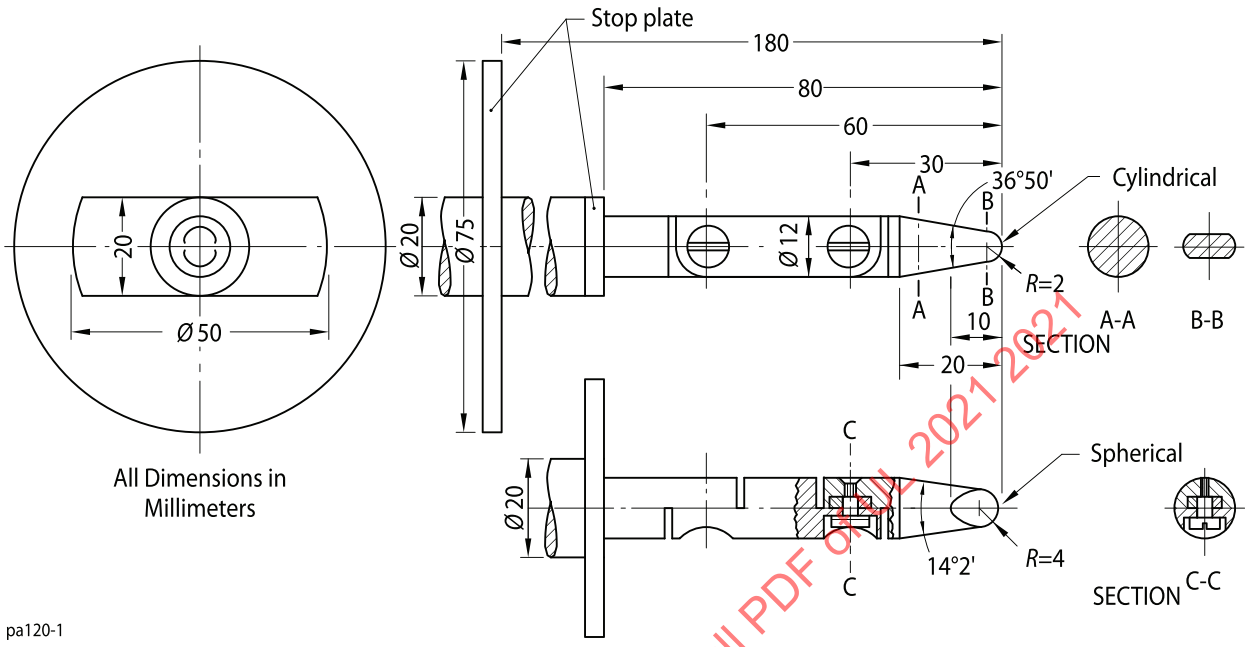


Figure 7.4

Articulate probe



7.26 During the examination of a heater in connection with the requirements in 7.17 – 7.25, a part of the outer enclosure that may be removed without the use of tools by the user of the heater (to permit the attachment of accessories, to allow access to means for making operating adjustments, or for other reasons) is to be disregarded– that is, it will not be assumed that the part in question affords protection against the risk of electric shock. A warning marking such as that specified in 59.7 is not considered to adequately protect against this risk of electric shock.

7.27 With reference to the requirements in 7.20 and 7.21, insulated brush caps are not required to be additionally enclosed.

7.28 During the examination of a heater in connection with the requirements in 7.17 – 7.25, a part of the outer enclosure that is removed with the use of tools by the user of the heater to permit resetting of the manual reset temperature limiting control is to be disregarded – that is, it will not be assumed that the part in question affords protection against the risk of electric shock. A warning marking such as that specified in 59.7 is not considered to adequately protect against this risk of electric shock.

Exception: A heater marked in accordance with 59.7 and that complies with 7.29 need not comply with this requirement.

7.29 A product may employ a resettable limit control when the reset means is inaccessible if designed in a manner that the product cannot be disassembled with readily available tools, such as screw drivers, wrenches, and the like, and the product is marked in accordance with 59.7. Such fasteners as rivets, one way screws, fasteners not readily accessible after assembly, and the like would be considered as causing the product to be not readily disassembled.

7.30 The rotor of a motor, pulley, belt, gear, or the like shall be enclosed or guarded to acceptably reduce the risk of injury to persons.

7.31 Any manual adjustable controls shall be resettable or adjustable so that moving or electrical parts will not cause a risk of fire, electric shock, or injury to persons to occur during the resetting or adjustment procedure. See 7.26 and 7.28 and Figure 7.5.

7.32 With reference to the requirement in 7.30, 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 judging the acceptability of the moving part are:

a) The degree of exposure,

b) The sharpness of the moving part,

c) The likelihood of unintentional contact with the moving part,

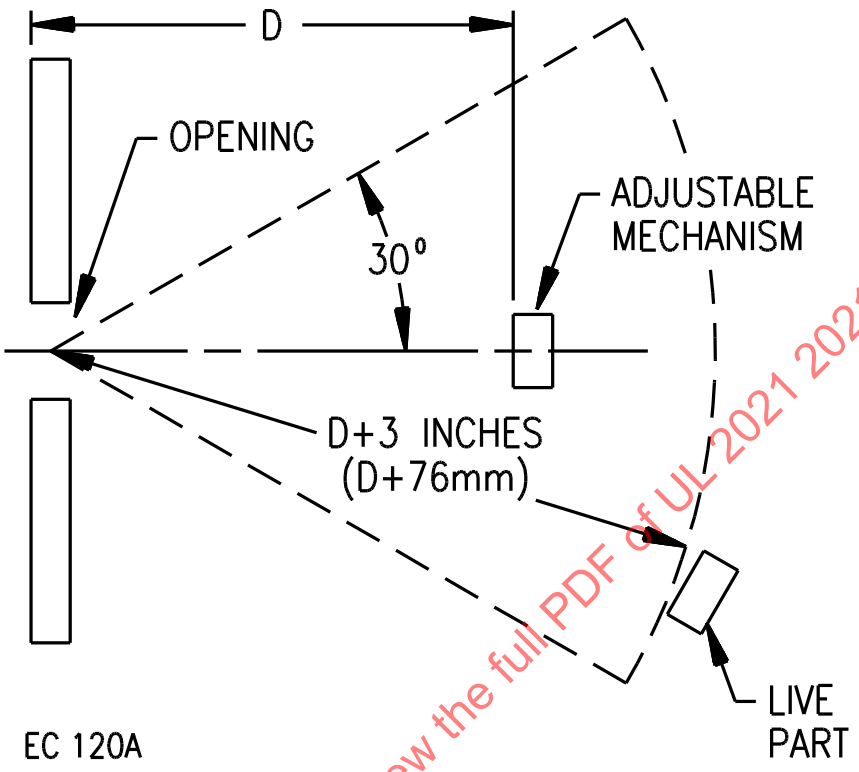
d) The speed of movement of the part, and

e) The likelihood of fingers, arms, or clothing being drawn into the moving part (such as at points where gears mesh, where a belt travels onto a pulley, or where moving parts close in a pinching or shearing action).

7.33 An uninsulated live part shall not be located behind an opening that may be used to make a user service function such as adjusting or resetting a manual limit control if a 1/8-inch (3.2-mm) diameter straight rod can be made to touch the live part when the rod is inserted through the opening and moved to all positions possible without producing an angle of more than 30 degrees between the rod and the line drawn between the center of the opening and the center of the face of the part to be adjusted. The length of the rod beyond the opening is not to exceed the distance between the opening and the face of the adjustable mechanism by more than 3 inches (76 mm). See Figure 7.5.

Figure 7.5

Accessibility of live part through enclosure opening



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

7.35 The door or cover of an enclosure shall be hinged:

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

b) If uninsulated live parts are exposed during the replacement of the fuse or resetting of the manual resettable device.

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

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

7.37 A spring latch, a magnetic latch, a dimple, or any other mechanical arrangement that will hold the door in place and would require some effort on the user's part to open it is considered to be an acceptable means for holding the door in place as required in 7.35.

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

8 Parts Subject to Pressure

8.1 Except as noted in 8.3 a pressure vessel having an inside diameter, width, height, or cross section diagonal of more than 6 inches (152 mm) with no limitations on length of vessel, and subject to a pressure of more than 15 pounds force per square inch gauge (psig) (103 kilonewtons per square meter or 10.5 grams force per square millimeter) shall be certified by the National Board of Boiler and Pressure-Vessel Inspectors and marked in accordance with the appropriate boiler and pressure vessel code symbol of the American Society of Mechanical Engineers (ASME) – "H", "M", "S", or "U" – for a working pressure no less than the pressure determined by applying 8.3.

8.2 If a pressure vessel, because of its application, is not covered under the inspection procedures of the ASME code, it shall be so designed and constructed that it will comply with the requirements in 8.3.

8.3 Except as noted in 8.5, a component of a heater (piping, fittings, air vents, and the like) that is subject to air or vapor pressure (including the vapor pressure of a superheated fluid) during intended or abnormal operation shall be capable of withstanding without failure a pressure equal to five times the working pressure.

8.4 As used in 8.3, working pressure may be defined as the highest of the following:

a) The highest pressure achieved during normal or abnormal operation of the heater,

b) The maximum pressure setting of a pressure relief device provided as part of the assembly,

c) The working pressure marked on the part.

8.5 A test need not be performed to determine whether or not a part complies with the requirement in 8.3 if the strength of the part is acceptable for the purpose as a result of its material and dimensions – for example, copper or steel pipe of standard sizes and provided with standard fittings might be considered to have the necessary strength.

8.6 If a test is necessary to determine if a part complies with the requirement in 8.3, two samples of the part are to be subjected to a hydrostatic-pressure test. Each sample is to be filled with water to exclude air and is to be connected to a hydraulic pump. The pressure is to be raised gradually to the specified test value, and is to be held at that value for 1 minute. The results are not acceptable if either sample bursts or leaks, except as indicated in 8.7.

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

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

8.9 Pressure-relief devices (see 8.14), fusible plugs, soldered joints, nonmetallic tubing, or other equivalent pressure-relief means may be employed to comply with the requirement in 8.8.

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

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

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

8.13 A pressure-relief device shall:

a) Be connected as close as possible to the pressure vessel or parts of the system that it is intended to protect,

b) Be so installed that it is accessible for inspection and repair and cannot be readily rendered inoperative,

c) Have its discharge opening so located and directed that the risk of scalding has been reduced to an acceptable degree, and

d) Have its discharge opening so located and directed that operation of the device will not deposit moisture on uninsulated live parts, or on insulation or components affected detrimentally by moisture.

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

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

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

9 Polymeric Materials

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

10 Assembly

10.1 Uninsulated live parts, a heating element, a switch, a lampholder, a temperature control, an attachment-plug receptacle, a motor-attachment plug, or similar component shall be mounted securely and, except as noted in 10.2, 10.3 and 10.9, shall be prevented from turning. See 10.4 and Strength of Adjustment Stop Test, Section 54.

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

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

b) The means for mounting the switch or the control is not subject to loosening as the result of its operation,

c) The spacings are not reduced below the minimum acceptable values if the switch or the control rotates,

d) The operation of the switch or the control is by mechanical means rather than direct contact by persons, and

e) The shifting of the switch or the control in position does not result in false indication of its setpoint with respect to the setpoint markings.

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

10.4 The means for preventing the turning mentioned in 10.1 is to consist of more than friction between surfaces – for example, a toothed lock washer which provides both spring take-up and an interference lock is acceptable as means to prevent turning of a small stem-mounted switch or other device having a single-hole mounting means.

10.5 Uninsulated live parts shall be secured to the base or mounting surface that they will be prevented from turning or shifting in position if such motion may result in a reduction of spacings below the minimum acceptable values indicated in 30.1 – 30.6.

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

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

10.8 A heater shall be completely assembled when it is shipped from the factory, except as noted in 10.9, when the heater is partially disassembled to facilitate packaging or installation, and the assembly of the heater is readily accomplished without causing a risk of fire, electric shock, or injury to persons.

10.9 A heating element that is not mounted securely in its intended position shall be acceptable for assembly during installation of a fixed heater (see 2.4) when all the following are met:

a) The heating element is packed in the same overall carton of the heater, or the heating element is packed in a separate carton that is secured together to the heater carton (such as by steel strapping or strong tape) so that the two cartons do not become separated during shipment,

b) The interconnecting leads and wiring intended for the electrical connection of the heating element are housed entirely within the heater, and the electrical connections are made with integral plugs and receptacles arranged so that no uninsulated live part capable of causing electric shock is accessible to unintentional contact when the heating element is not in place, and

c) Information concerning assembly of the heating element to the heater shall be provided in the installation instructions. See 60.2.3.

11 Protection Against Corrosion

11.1 Except as noted in 11.2, iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or other equivalent means if the deterioration of such unprotected parts would be likely to result in risk of fire, electric shock, explosion, or personal injury.

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

heating element operating in air and terminal parts attached directly to the heating element need not be protected against corrosion.

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

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

12 Adjustment Stop

12.1 An adjustment stop of a control shall not be damaged so as to cause a reduction of spacings, erroneous indications of the control setpoint, or other conditions that may result in a risk of fire, electric shock, or injury to persons when tested in accordance with the Strength of Adjustment Stop Test, Section 54.

13 Supply Connections

13.1 Permanently connected appliances

13.1.1 Except as noted in 13.1.2 – 13.1.6, a heater intended for permanent connection to the power supply shall have provision for the connection of one of the wiring systems that, in accordance with the National Electrical Code, ANSI/NFPA 70 would be acceptable for the heater.

13.1.2 Provision for the connection of a wiring system (see 13.1.1) is not required for an air heater having a 50 pound mass (22.7 kg mass) or less and intended to be supported entirely by a ceiling outlet box that is not furnished with the heater, provided that:

a) The heater is marked (where the marking will be visible during the examination of the field-wiring connections) "This heater to be mounted to a standard outlet box," and

b) The temperature in the outlet box to which the heater will be mounted will not be higher than 60°C (140°F) under conditions of intended operation.

13.1.3 A wall-mounted heater intended to be supported entirely by a wall outlet box may also be accepted under the conditions mentioned in 13.1.2 if, in addition, it does not exert a bending moment greater than 200 pound-force-inches (22.6 N·m) on the outlet box to which it is mounted.

13.1.4 Leads (including a grounding conductor as specified by the National Electrical Code, ANSI/NFPA 70) provided for the power supply connection of a ceiling-panel or T-bar heater, may be brought out through factory-attached flexible conduit not less than 3 feet (0.91 m) long and not more than 11 feet (3.4 m) long. The leads shall extend at least 6 inches (152 mm) beyond the end of the flexible conduit. An outlet box need not be provided at the free end of the conduit.

Exception: A grounding conductor is not required if:

a) The conduit is not longer than 6 feet (1.8 m),

b) No circuit conductor protected by an overcurrent protective device rated at more than 20 amperes is included and,

c) The conduit is no larger than 3/4 inch trade size, unless the fittings are identified as providing grounding.

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

13.1.6 A terminal compartment intended for the connection of a supply raceway shall be so attached to the heater as to be prevented from turning with respect thereto.

13.1.7 Equipment intended for permanent connection to the power supply shall be provided with field-wiring terminals or leads (pigtail leads) for connection of the power-supply conductors.

13.1.8 Each such field wiring terminal or pigtail lead shall be acceptable for connection of a field conductor having an ampacity in accordance with the National Electrical Code, ANSI/NFPA 70, not less than 125 percent of the current rating of the equipment at the supply terminal or lead. If the rating is 24 amperes or less, the terminal or pigtail lead shall be rated for connection of a 10 AWG (5.3 mm^2) copper wire or a 8 AWG (8.4 mm^2) aluminum wire if the equipment is to be field-connected with aluminum conductors.

13.1.9 A pigtail lead shall be no more than two standard wire sizes smaller than the branch circuit power supply conductor (copper) to which it will be connected, and except as indicated in 13.1.10, shall not be smaller than 14 AWG (2.1 mm^2) copper.

13.1.10 A heater rated 16 amperes or less, that is not intended for connection of 10 AWG (5.3 mm^2) (copper) power-supply conductors, shall be for connection to a 15- or 20-ampere branch circuit, as appropriate for the rating of the equipment, and shall be marked in accordance with 59.36.

13.1.11 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 derating factor given in the National Electrical Code, ANSI/NFPA 70, shall be applied.

13.1.12 For the purpose of these requirements, field-wiring terminals are considered to be the terminals to which power-supply, control, or equipment-grounding connections will be made in the field when the heater is installed. It is to be assumed that 60°C (140°F) wire will be used for connections to a heater rated at 80 amperes or less and that 75° C (167° F) wire will be used with a heater rated at more than 80 amperes.

13.1.13 A field-wiring terminal or lead for connection of an equipment-grounding conductor shall be provided. See 13.1.27.

13.1.14 A field-wiring terminal intended solely for connection of an equipment-grounding conductor shall be capable of securing a conductor having a size determined by the rating of the branch circuit overcurrent device to which the equipment will be connected, in accordance with Table 250-95 of the National Electrical Code, ANSI/NFPA 70, except as indicated in 13.1.15.

13.1.15 A conductor smaller than that indicated in 13.1.14 may be used if the bonding connection does not open when carrying for 2 minutes twice the current equal to the rating of the branch circuit overcurrent device.

13.1.16 A field-wiring terminal shall be provided with a solder lug or with a pressure wire connector securely fastened in place (for example, firmly bolted or held by a screw), except that a wire-binding screw may be employed at a field-wiring terminal intended to accommodate a 10 AWG (5.3 mm^2) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in position.

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

Exception: A solder lug is not acceptable for use as a grounding terminal.

13.1.18 A wire-binding screw at a field-wiring terminal shall not be smaller than No. 10 (4.8 mm), except that a No. 8 (4.2 mm) screw may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm^2) conductor, and a No. 6 (3.5 mm) screw may be used for the connection of a 16 AWG (1.3 mm^2) or 18 AWG (0.82 mm^2) control-circuit conductor.

13.1.19 It should be noted that according to the National Electrical Code, ANSI/NFPA 70, 14 AWG (2.1 mm^2) is the smallest conductor which may be used for branch-circuit wiring, and thus is the smallest conductor that may be anticipated at a terminal for the connection of a power-supply wire.

13.1.20 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050 inch (1.27 mm) thick, except that a plate not less than 0.030 inch (0.76 mm) thick is acceptable if the tapped threads have the required mechanical strength. There shall be two or more full threads in the metal, which may be extruded if necessary to provide the threads.

13.1.21 Upturned lugs or a cupped washer shall be capable of retaining a conductor of the size mentioned either in 13.1.11 [but not smaller than 14 AWG (2.1 mm^2)] or in 13.1.14, whichever is applicable, under the head of the screw or the washer.

13.1.22 A wire-binding screw shall thread into metal.

13.1.23 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 if necessary because of the requirement in 28.1, 28.4, 28.5, or 29.2.

13.1.24 A field-wiring terminal intended for the connection of a grounded conductor shall be of or be plated with a metal substantially white in color and shall be 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 shall be finished to show a white or gray color and shall be distinguishable from the other leads.

13.1.25 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.

13.1.26 The requirements in 13.1.24 and 13.1.25 relating to color coding of a lead for identification do not apply to internal wiring that is not visible in a wiring compartment in which field connections are to be made.

13.1.27 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal-shaped, slotted, or both. A pressure wire connector intended for connection of such a conductor shall be plainly identified, such as by being marked G, GR, GND, Ground, Grounding, by the symbol ⏚ or the like, or by a marking on a wiring diagram provided on the heater. The wire-binding screw or pressure wire connector shall be so located that it is unlikely to be removed during servicing of the heater and shall have upturned lugs or the equivalent to retain the conductor.

13.1.28 Except as noted in 13.1.29, the free length of a lead inside an outlet box or wiring compartment shall be 6 inches (152 mm) or more if the lead is intended for field connection to an external circuit.

13.1.29 The lead may be less than 6 inches (152 mm) in length if it is evident that the use of a longer lead may result in damage to the lead insulation.

13.1.30 A heater that is not strictly portable, but is not obviously intended to be permanently connected, may be acceptable if provided with a short length of flexible cord and an attachment plug for supply connection. The investigation of such a feature will include consideration of the utility of the heater and the necessity of having it readily detachable from its source of supply by means of the attachment plug.

13.1.31 A wall mounted heater weighing less than 50 pounds shall not be provided with a flexible cord and plug.

13.2 Cord-connected heaters

13.2.1 When tested in accordance with 13.2.2, a cord connected wall-mounted heater is acceptable if:

a) The security of the attachment of the heater to the wall is not impaired,

b) There is no evidence of risk of fire or electric shock,

c) The insulation resistance between live parts and dead metal parts is not less than 50,000 ohms, and

d) The heater withstands for 1 minute without breakdown the application of 60-hertz potential of 1000 volts between live parts and dead metal parts.

13.2.2 The heater is to be mounted in the intended manner and subjected to a static force of 300 pounds (1.33 kN) as indicated in Figure 13.1 and Figure 13.2. The force is to be applied through a nominal 2 by 4 inch (38 by 89 mm) wood member with the nominal 4-inch (89-mm) side horizontal.

Figure 13.1

Fireplace type

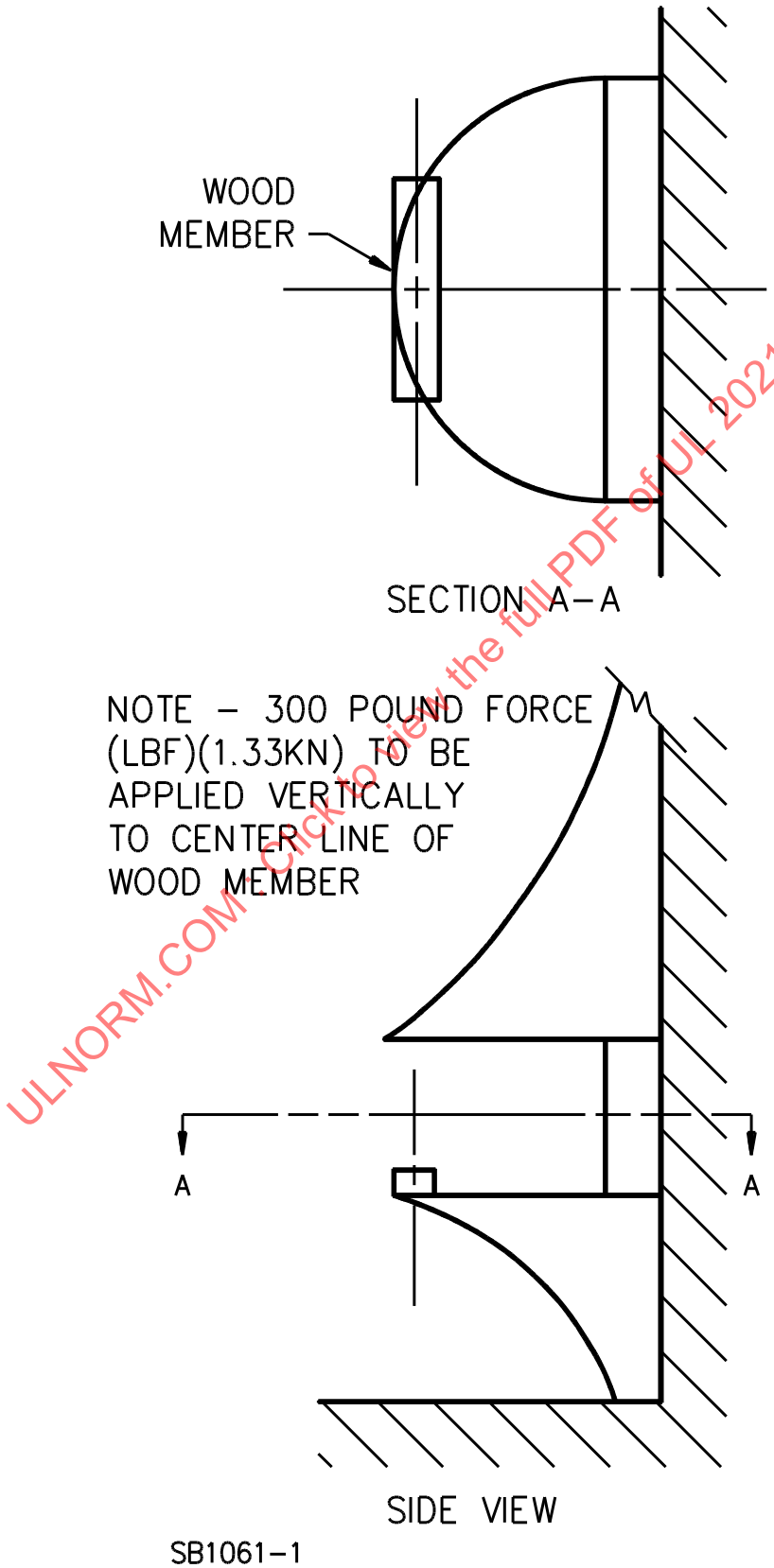


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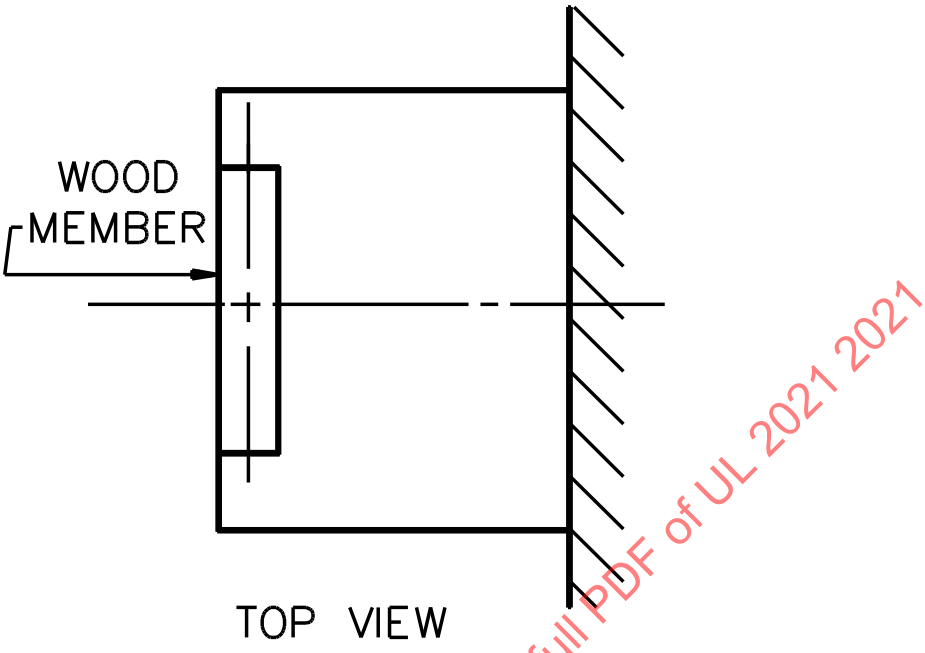
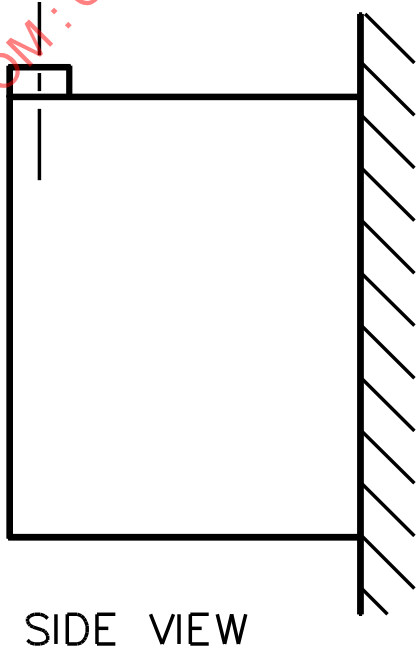
Figure 13.2

Wall surface-mounted type



TOP VIEW

NOTE – 300 POUND FORCE (LBF) (1.33 KN) TO BE APPLIED VERTICALLY TO CENTER LINE OF WOOD MEMBER



SIDE VIEW

SB1060-1

13.2.3 Mounting brackets and any necessary fasteners required for mounting the heater shall be provided as part of the product. Optional mounting kits may be available if marked in accordance with 59.17.

13.2.4 Means shall be provided to prevent a cord-connected, wall mounted heater from being dislodged from the wall. If the construction of the heater, mounting means, or both, is such that the bottom of the heater may swing or move, means shall be provided to secure the bottom edge of the heater to the wall if such movement could cause the heater to be dislodged.

13.2.5 A cord-connected, freestanding, floor-supported heater as described in 13.1.30, shall not have dimensions greater than 8 feet long, 6 feet high, and 2-1/2 feet deep (2.4 m long, 1.8 m high, and 0.76 m deep).

13.2.6 If a heater is provided with a directly attached flexible cord, an attachment plug shall be provided on the cord for attachment to the supply circuit. If an attached flexible cord is not provided, the heater shall have terminals employing male pins, blades, or the equivalent that will accommodate an acceptable plug. The length of the detachable power-supply cord or attached power-supply cord (including fittings) shall not be less than 6 feet (1.8 m) and not more than 8 feet (2.4 m).

Exception: The length of cord for Types SRDT and SPT-3 is specified in note b of Table 13.1.

Table 13.1
Acceptable types of cord

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

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

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

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

[d] The maximum temperature on a heater are to be determined in accordance with the Continuous Operation Test, Section 38.

13.2.7 The size of the flexible cord, based on the current rating of the heater, shall be in accordance with Table 13.2.

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

13.2.9 The flexible cord shall be as indicated in Table 13.1 or shall be of a type having such properties that it will be at least equally serviceable for the particular application.

Table 13.2
Cord wire size based on heater current rating[a]

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

[a] This table limits the heater current on the basis of a cord wire size, type of cord, and type of connection between the cord wires and blades of the attachment plug. For current limitation based on the attachment plug rating, see 13.2.8.

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

[c] Applies to any acceptable cord type.

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

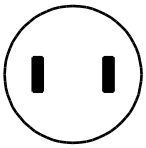
13.2.10 The flexible cord provided with a heater intended for use out of door (such as a drive-in-theater heater) shall be marked with the suffix letters "WA".

13.2.11 The attachment plug (of a permanently attached cord or of a cord set) shall be acceptable for its intended use. Some of the more common plug configurations are shown in Figure 13.3.

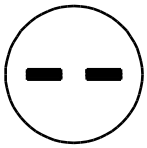
Figure 13.3

Attachment plug configurations

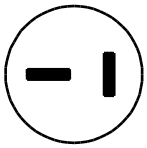
2–POLE, 3–WIRE, NONGROUNDING:



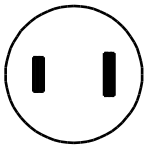
15 amperes,
125 volts



15 amperes,
250 volts

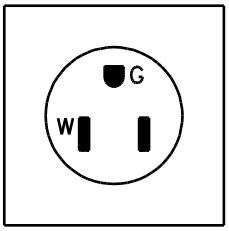


20 amperes,
250 volts

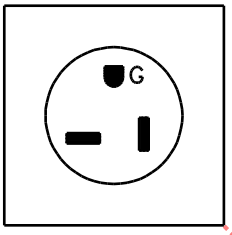


30 amperes,
250 volts

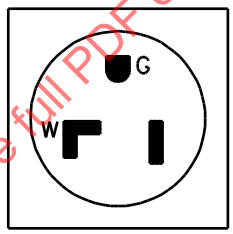
2–POLE, 3–WIRE, GROUNDING:



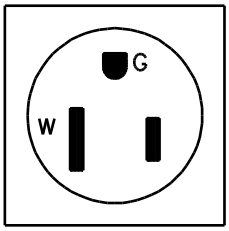
15 amperes,
125 volts



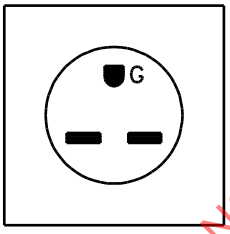
20 amperes,
125 volts



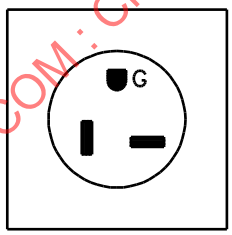
30 amperes,
125 volts



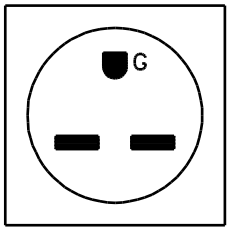
50 amperes,
125 volts



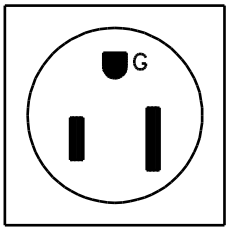
15 amperes,
250 volts



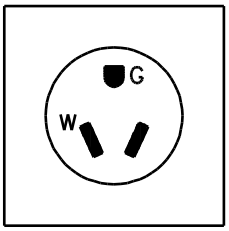
20 amperes,
250 volts



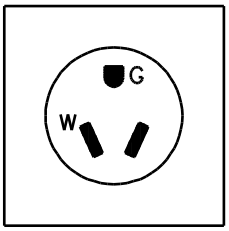
30 amperes,
250 volts



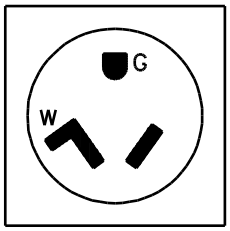
50 amperes,
250 volts



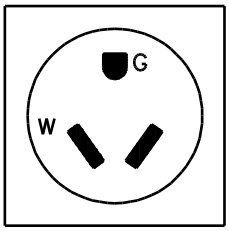
15 amperes,
277 volts



20 amperes,
277 volts



30 amperes,
277 volts



50 amperes,
277 volts

AA130

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

13.3 Strain relief

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

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

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

13.3.4 When tested in accordance with 13.3.5, the strain-relief means provided on the flexible cord shall withstand for 1 minute, without displacement, a direct pull of 35 pounds force (155 N force) applied to the cord, with the connections within the heater disconnected.

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

13.4 Pin terminals

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

13.4.2 A guard or the equivalent shall be provided to prevent unintentional contact with pins when they are live.

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

13.4.4 The requirement in 13.4.3 is intended primarily to provide for the maintenance of spacings in accordance with 30.1 – 30.6 and Table 30.2, and for spacings between pin-type terminals as indicated in Table 13.3. Under this requirement, consideration is also to be given to the means for locking terminals in position to maintain tightness.

13.4.5 If a heater employs three or more pin terminals intended for use with a plug that covers all the pins, the terminals shall be so spaced that they will not accommodate a flatiron or appliance plug or a cord connector; and the plug that these pins will accommodate shall be acceptable for the particular application.

13.4.6 The dimensions of pins and their center-to-center spacings (including the corresponding spacings of the female contacts of general-use plugs which will accommodate these arrangements of pins) are as indicated in Table 13.3.

Table 13.3
Pins

Type and rating of plug which accommodates the pins	Configuration of pins				Diameter of pins		Length of pins	
	number	arrange-ment	Spacing between centers					
			inches	(mm)	inches	(mm)	inches	(mm)
Appliance plug rated for 5 Amperes at 250 Volts and for 10 Amperes at 125 Volts	2	In line	1/2	(12.7)	5/32 – 0.005	(3.84– 4.09)	9/16 – 5/8	(14.3 – 15.9)
Flatiron plug rated for 5 Amperes at 250 Volts and for 10 Amperes at 125 Volts	2	In line	11/16	(17.5)	3/16 – 0.005	(4.65 – 4.90)	3/4 – 7/8	(19.0 – 22.2)
Jumbo appliance plug rated for 10 Amperes at 250 Volts and 15 Amperes at 125 volts[a]	2	In line	1-1/16	(27.0)	3/16 – 0.005	(4.65 – 4.90)	3/4 – 7/8	(19.0 – 22.2)
Reversible plug (for two-heat control) rated for 10 Amperes at 250 Volts and or 15 Amperes at 125 volts[a]	3	In line	7/8	(22.2)	3/16– 0.005	(4.65 – 4.90)	3/4 – 7/8	(19.0 – 22.2)
Reversible plug (for two- or three-heat control) rated for 10 Amperes at 250 Volts and for 15 Amperes at 125 Volts[a]	3	One pin at apex of an equilateral triangle	7/8	(22.2)	3/16– 0.005	(4.65 – 4.90)	3/4 – 7/8	(19.0 – 22.2)

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

13.5 Bushings

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

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

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

13.5.4 A separate soft-rubber, neoprene, or polyvinyl chloride bushing of good quality may be employed in the frame of a motor or in the enclosure of a capacitor attached to a motor (but not elsewhere in a heater, except as indicated in 13.5.5) provided that:

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

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

13.5.5 A bushing of any of the materials mentioned in 13.5.4 may be employed at any point in a heater if used with cord of a type for which an insulating bushing is not required, and if the edges of the hole in which the bushing is mounted are smooth and free from burrs, fins, and the like.

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

13.6 Pilot lights

13.6.1 A cord-connected heater shall be provided with a pilot light having a non-user-replacable lamp (e. g. LED) or lens that glows red or amber. The light shall:

a) Be located on the front or top surface of the heater;

b) Protrude from the top surface of the heater if so located; and

c) Comply with 13.6.2. The pilot light shall be connected to the heater circuit so that it is energized whenever the on-off switch (see 28.11) is in the on position. Compliance of the pilot light shall be determined in all operating modes when the on-off switch is in the on position.

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

a) The heating element for the heater consists of a single element,

b) The element is not cycled by an automatic control,

c) The element cannot be operated by either a manual or automatic control, at a reduced rating so that it can no longer be considered a visibly glowing element in accordance with 59.25, and

d) The heater complies with the visibility requirement of 13.6.2.

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

Exception No. 3: A pilot light is not required on a hearth type heater having a flame effect feature. The flame effect feature shall have a majority red or amber color, be illuminated by at least two lamps and shall comply with the visibility requirement of 13.6.2. The flame effect feature shall be connected to the heater circuit so that it is energized whenever the on-off switch (see 28.11) is in the on position. Compliance of the flame effect feature shall be determined in all operating modes when the on-off switch is in the on position.

13.6.2 The lens of a pilot light mentioned in 13.6.1 shall be visible from a point 10 feet (3 m) in front of the center of the heater and 5 feet (1.5 m) above the floor. Compliance with this requirement shall be determined while the heater is:

a) Standing on the floor if the heater is intended for placement on the floor while in operation, or

b) Elevated from the floor by 3 feet (0.91 m) if the heater is intended for use at an elevated location.

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

14 Current-Carrying Parts

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

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

a) Within a motor or associated governor, and

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

15 Internal Wiring

15.1 General

15.1.1 The internal wiring of a heater shall consist of wires of a size and type or types that are acceptable for the particular application, when considered with respect to:

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

b) Its exposure to oil or grease, and

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

15.1.2 For the purpose of these requirements, the internal wiring of an appliance is considered to be all the interconnecting wiring beyond the point where the power-supply cord of a cord-connected appliance enters the enclosure, or beyond the wiring terminals or leads for power-supply connection of a permanently connected appliance even though some of such wiring:

a) May not be completely enclosed, and

b) May be in the form of flexible cord.

15.1.3 There is no temperature limit applicable to a conductor (except as noted in 14.1) provided with beads of noncarbonizable material or the equivalent.

15.2 Protection of wiring

15.2.1 The wiring and connections between parts of a heater shall be protected or enclosed, except that a length of flexible cord may be employed for external connections, or for internal connections that may be exposed during servicing, if flexibility of the wiring is essential.

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

a) Shall be a jacketed type at least equivalent to Type SP-2 flexible cord. Appliance wiring material is not acceptable unless provided with sleeving or tubing.

b) Shall be routed along the metal surface of the heater enclosure and shall be so secured as to minimize the likelihood of its being hooked or grasped.

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

15.2.4 Internal wiring that is exposed through an opening in the enclosure of a heater is considered to be protected as required in 15.2.1 – 15.2.3 if, when judged as though it were film-coated wire, the wiring would be acceptable according to 7.17– 7.20. Internal wiring within an enclosure is acceptable if, even though it can be touched with the probe, it is so protected or guarded that it cannot be grasped or hooked in such a manner that it could be subjected to stress.

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

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

15.2.7 A hole by means of which insulated wires pass through a sheet-metal wall within the overall enclosure of a heater shall be provided with a smooth, rounded bushing or shall have smooth, rounded surfaces upon which the wires may bear, to prevent abrasion of the insulation. A flexible cord used for external interconnection as mentioned in 15.2.1 shall be provided with bushings and strain relief in accordance with 13.3.1 – 13.3.5 and 13.5.1 – 13.5.6 unless the construction is such that the cord will be protected from stress or motion.

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

15.3 Splices

15.3.1 All electrical connections, such as wire nuts, splicing wire connectors, quick-connect terminals, terminal connectors, multi-pin and other forms of wire connectors, shall comply with the following standards:

a) UL 310, the Standard for Electrical Quick-Connect Terminals;

b) UL 486A-486B, the Standard for Wire Connectors;

c) UL 486C, the Standard for Splicing Wire Connectors;

d) UL 486E, the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors; or

e) UL 1977, the Standard for Component Connectors for Use in Data, Signal, Control and Power Applications.

Exception No. 1: This requirement is not applicable to current-carrying connections that are located in a low-voltage circuit (see 2.13).

Exception No. 2: This requirement is not applicable to the following types of connections:

a) brazed or welded connections,

b) soldered connections on printed circuit boards located in a low-voltage circuit (see 2.13), or

c) connections on small components that are mounted on printed circuit boards located in a low-voltage circuit (see 2.13).

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

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

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

15.4 Separation of circuits

15.4.1 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 a barrier or spacing from an uninsulated live part connected to a different circuit.

15.4.2 Low-voltage and high-voltage circuits, for example, are considered to be different circuits with reference to the requirement in 15.4.1.

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

15.4.4 Except as noted in 15.4.5 and 15.4.6, barriers shall be provided to separate conductors that will be field-installed from:

a) Conductors of any other circuit that will be field-installed,

b) Conductors of any other circuit that are factory-installed,

c) Uninsulated live parts of any other circuit, and

d) Live parts of the same circuit if unacceptable operation can result from short-circuiting of the live parts.

15.4.5 The barriers mentioned in 15.4.4 (a) and (b) are not required if the conductors involved are, or will be, insulated for the maximum voltage of either circuit.

15.4.6 The barriers mentioned in 15.4.4 (c) and (d) are not required if the field-installed conductors will be acceptable for general wiring or fixture wires suitable for 600 volts.

15.4.7 If the field-installed conductors will have insulation less than that for the conductors described in 15.4.6, the barrier mentioned in 15.4.4(d) is not required if the circuit is low-voltage and if short-circuiting of the live parts will not result in unacceptable operation.

15.4.8 With respect to 15.4.4 (a) and (b), a removable barrier or one having openings for the passage of conductors may be employed, provided instructions for the use of the barrier are a permanent part of the

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

15.4.9 Segregation of field-installation conductors from other field-installation conductors and from uninsulated live parts of the heater connected to different circuits may be accomplished by so arranging the location of the openings in the enclosure for the various conductors (with respect to the terminals or other uninsulated live parts) that there is no likelihood of the intermingling of the conductors or parts of different circuits. If the number of openings in the enclosure does not exceed the minimum required for the intended wiring of the heater and if each opening is located opposite a set of terminals, it is to be assumed, for the purpose of determining compliance with 15.4.4, that the conductors entering each opening will be connected to the terminals opposite the opening. If more than the minimum number of openings are provided, the possibility of conductors entering at points other than opposite the terminals to which they are intended to be connected and contacting insulated conductors or uninsulated current-carrying parts connected to a different circuit is to be investigated. To determine if a heater complies with the requirement in 15.4.4, it is to be wired as it would be in service; and in doing so, a reasonable amount of slack is to be left in each conductor within the enclosure, and not more than average care is to be exercised in stowing this slack in the wiring compartment.

15.5 Barriers

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

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

16 Heating Elements

16.1 A heating element shall be securely supported.

16.1.1 A sheath type heating element shall comply with the requirements in:

a) The Standard for Sheathed Heating Elements, UL 1030; or

b) The Standard for Electric Heating Appliances, UL 499, except the minimum sheath thickness shall be 0.016 in. (0.33 mm).

16.2 In determining if a heating element complies with the requirement in 16.1, consideration is to be given to sagging, loosening, and other adverse conditions of the element resulting from:

a) Continuous heating or

b) Flexing of the element supports or related wiring due to alternate heating and cooling of the element.

17 Electrical Insulation

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

17.2 Insulating material employed in a heating appliance is to be judged with respect to its particular application. Materials such as mica, some molded compounds, and certain refractory materials are usually acceptable for use as the sole support of live parts; and some other materials that are not for general use, such as magnesium oxide, may be acceptable if used in conjunction with other less hygroscopic insulating materials or if located and protected so that they are not subject to mechanical damage and are resistant to the absorption of moisture. When it is necessary to investigate a material to determine whether or not it is acceptable, consideration is to be given to its mechanical strength, dielectric properties, insulation resistance (see 47.1), heat-resistant qualities, the degree to which it is enclosed or protected and any other features having a bearing on the likelihood that a risk of fire, electric shock, or injury to persons may occur, under conditions of actual service. All of these factors are considered with respect to thermal aging.

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

18 Thermal Insulation

18.1 Thermal insulation shall be of such nature and located and mounted or supported so that it will not be adversely affected by any intended operation of the heater. See also 38.11.

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

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

18.4 Flammable thermal insulation of other flammable material is not acceptable if it is located so that it may be in a current of air within the heater.

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

18.6 Some types of mineral-wool thermal insulation contain conductive impurities in the form of slag that make its use unacceptable if in contact with uninsulated live parts. See 47.1.

19 Motors

19.1 General

19.1.1 A motor shall comply with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

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

19.1.3 With reference to the requirement in 19.1.2, film-coated wire is not required to be additionally treated to resist absorption of moisture, but fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials shall be provided with impregnation or be otherwise treated to resist moisture absorption.

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

19.2 Insulation systems

19.2.1 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 specified in Table 19.1 at the thicknesses specified are permitted to be used without further evaluation.

19.2.2 For Class A insulation systems employing other materials or thinner materials than those indicated in Table 19.1 or a combination of materials, the materials, whether polymeric or not polymeric (treated cloth, for example), shall comply with the requirements in 19.2.3.

19.2.3 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.

19.2.4 Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with the Standard for Systems of Insulating Materials – General, UL 1446.

19.2.5 All insulation systems employing integral ground insulation shall comply with the requirements specified in the Standard for Systems of Insulating Materials – General, UL 1446.

Table 19.1
Primary Class A insulating materials and minimum thicknesses

Material	Minimum thickness	
	mm	(inches)
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)

20 Overcurrent Protection, General

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

20.2 Heating equipment employing infrared heating means shall have overcurrent protection not exceeding 50 amperes.

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

20.4 The overcurrent protection mentioned in 20.1 – 20.3 and 21.5 shall be of a type acceptable for branch circuit protection in accordance with the National Electrical Code, ANSI/NFPA 70. The overcurrent protective devices shall be factory installed as an integral part of the heater or shall be provided by the heater manufacturer as a separate assembly, for independent mounting, for use with the heater. See 59.38.

20.5 A fuseholder or circuit breaker shall be of a type acceptable for the particular application and shall not be accessible from outside the enclosure without opening a door or cover, except that the operating handle of a circuit breaker may project outside the enclosure. A plug fuseholder shall be so installed that uninsulated live parts other than the screw shell will not be exposed to contact by persons removing or replacing fuses.

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

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

20.8 The overcurrent protection may be omitted from the primary of a Class 2 transformer. See 23.2.2.

20.9 Overcurrent protection for a tapped high-voltage control circuit and for a transformer may be omitted from a cord-connected heater employing one of the attachment plug configurations shown in Figure 13.3, or from a permanently connected heater that is supplied by a branch circuit rated 15 amperes or less, provided the heater conductors, other than the supply cord, do not extend beyond the heater enclosure and either:

a) Are not smaller than 18 AWG (0.82 mm^2), or

b) If smaller than 18 AWG, are not more than 18 inches (457 mm) long and are an integral part of a motor, transformer, printed wiring assembly, or the like.

20.10 Fuses shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1; and the applicable UL 248 Part 2 (e.g. UL 248-5). Defined use fuses that comply with UL 248-1 and another applicable UL standard(s) for fuses are considered to comply with this requirement.

20.11 Fuseholders shall comply with one of the following:

a) *Deleted*

b) The Standard for Fuseholders – Part 1: General Requirements, UL 4248-1, and the applicable Part 2 (e.g. UL 4248-9).

20.12 Circuit breakers shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

Exception: Circuit breakers used in telecommunications circuitry that comply with the Standard for Circuit Breakers For Use in Communications Equipment, UL 489A, need not comply with UL 489.

20.13 Circuit breakers having integral ground fault circuit interrupter capability for protection against electrical shock shall additionally comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943.

20.14 Supplementary protectors shall comply with the Standard for Supplementary Protectors for Use in Electrical Equipment, UL 1077.

21 Overcurrent Protection, Motors and Motor Circuits

21.1 Thermal protection devices integral with the motor shall comply with one of the following:

a) The Standard for Overheating Protection for Motors, UL 2111;

b) The Standard for Thermally Protected Motors, UL 1004-3; or

c) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1; and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2 Particular Requirements for Thermal Motor Protectors, UL 60730-2-2; in conjunction with the Standard for Thermally Protected Motors, UL 1004-3 (to evaluate the motor-protector combination).

21.2 Impedance protection shall comply with one of the following:

a) The Standard for Overheating Protection for Motors, UL 2111; or

b) The Standard for Impedance Protected Motors, UL 1004-2.

21.3 Electronic protection integral to the motor shall comply with the Standard for Electronically Protected Motors, UL 1004-7.

21.4 Except as indicated in 21.3, electronically protected motor circuits shall comply with one of the following. See 3.3.4 for basic control requirements:

a) The Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991. When the protective electronic circuit is relying upon software as a protective component, it shall comply with the requirements in the Standard for Software in Programmable Components, UL 1998. If software is relied upon to perform a safety function, it shall be considered software Class 1;

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1. If software is relied upon to perform a safety function, it shall be considered software Class B; or

c) The Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal and Energy, UL 61800-5-1.

Exception: Compliance with the above standards is not required for an electronically protected motor circuit if there is no risk of fire, electric shock, or injury to persons during abnormal testing with the motor electronic circuit rendered ineffective; compliance with the applicable requirements of this end product standard is then required.

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

21.6 A fuse may be used to provide the necessary overload protection if the construction complies with the requirements with the largest-ampere-rated fuse that can be mounted in the fuseholder or with the

intended noninterchangeable fuse. The fuse used to provide this protection need not be of a type required for branch-circuit protection, provided the heater is marked in accordance with 59.12.

21.7 A motor and motor circuit, except as indicated in 21.8, in a heater rated at more than 16 amperes shall be protected by an overcurrent device acceptable for branch circuit protection and having a maximum ampere rating in accordance with the National Electrical Code, ANSI/NFPA 70. Such short circuit and ground fault overcurrent protection shall be provided as part of the heater unless it can be determined (in accordance with 20.3) that equivalent short circuit and ground fault overcurrent protection will be incorporated as a protective device in the branch circuit to which the heater will be connected.

21.8 The requirement in 21.7 does not apply to a motor rated at 1/8 horsepower (93 W output) or less connected to a circuit having overcurrent protection at 50 amperes or less.

21.9 A motor having an inherent thermal protector that complies with the requirements for such devices is acceptable with respect to the requirement in 21.7 if, in the heater, 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.

22 Overcurrent Protection, High-Voltage Control Circuit Conductors

22.1 Direct-connected high-voltage control circuit

22.1.1 For the purpose of these requirements, a direct-connected high-voltage control circuit is one that is supplied from a branch circuit separate from a branch circuit that supplies other loads within the heater. It is not tapped from the load side of the overcurrent device or devices of the controlled circuit or circuits within the heater. See 59.43.

22.2 Tapped high-voltage control circuits

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

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

22.2.3 A tapped high-voltage control circuit conductor shall be provided with overcurrent protection. The rating of the overcurrent-protective device or devices shall not exceed the applicable value specified in Table 22.1.

Exception No. 1: Devices that are noted in 20.9, need not comply with this requirement.

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

Exception No. 3: An overcurrent-protective device of a higher rating than specified in Table 22.1 may be used provided the conductor complies with the requirements specified in the Short-Circuit Tests, Section 43.

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

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

a) Complies with the requirements for Overcurrent Protection, Transformers, Section 23, and

b) Does not exceed the applicable value specified in Table 22.1 multiplied by the ratio of secondary to primary rated transformer voltage.

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

Exception: The overcurrent-protective device or devices need not be provided as part of the heater if, based on the marked rating or ratings of the heater, the rating of the branch circuit overcurrent-protective device does not exceed the applicable value specified in Table 22.1.

Table 22.1
Overcurrent-protective device rating for control circuit conductors

Control circuit conductor size AWG (mm^2)	Maximum rating of overcurrent-protective device, Amperes			
	Conductors contained in control equipment enclosure		Conductors extending beyond control equipment enclosure	
	Copper	Aluminum[a]	Copper	Aluminum[a]
18 (0.82)	25	–	7	–
16 (1.3)	40	–	10	–
14 (2.1)	100	–	45	–
12 (3.3)	120	100	60	45
10 (5.3)	160	140	90	75
Larger than 10	b	b	c	c

[a] Includes copper-clad aluminum.

[b] 400 percent of value specified for 60°C conductors in Table 310-17 of the National Electrical Code, ANSI/NFPA 70.

[c] 300 percent of value specified for 60°C conductors in Table 310-16 of the National Electrical Code, ANSI/NFPA 70.

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

a) A circuit breaker acceptable for branch circuit protection;

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

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

The heater shall be marked in accordance with 59.39 – 59.41.

23 Overcurrent Protection, Transformers

23.1 High-voltage transformers

23.1.1 General

23.1.1.1 A transformer (including an autotransformer), other than one as described in 20.9 or 23.2.1, is considered to be a high-voltage transformer and shall:

a) Be provided with thermal overload protection in accordance with 23.1.2.1,

b) Be protected by an overcurrent device in accordance with 23.1.2.1 – 23.1.3.6, or

c) Comply with the Burnout Test – High-Voltage Transformers, Section 45.

23.1.2 Thermal overload protection

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

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

b) If the device is a nonrenewable thermal cutoff type, the Burnout Test – High-Voltage Transformers, Section 45.

23.1.2.2 A thermal cutoff that is used to provide thermal overload protection shall comply with the requirements in the Standard for Thermal-Links – Requirements and Application Guide, UL 60691. A manual or automatic reset thermal protector shall have an endurance rating of not less than 6000 cycles when tested in accordance with Endurance Test, Section 42, in this Standard and shall comply with the requirements for the calibration of temperature-limiting controls in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873. Compliance with the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills the UL 873 requirements.

23.1.3 Overcurrent protection

23.1.3.1 If a high-voltage transformer is protected by an overcurrent device, such protection shall comply with the requirements specified in 23.1.3.2 – 23.1.3.6.

23.1.3.2 Except as noted in 23.1.3.3, 23.1.3.4, and 23.1.3.5, a high-voltage transformer shall be protected by an overcurrent device or devices, located in the primary circuit and rated not more than 15 amperes or 125 percent of the rated transformer primary current, whichever is greater.

23.1.3.3 Overcurrent protection located in the primary circuit of a transformer need not be provided as part of the heater if based on the marked rating of the heater, the rating of the branch circuit overcurrent-protective device does not exceed the applicable value specified in 23.1.3.2. See 59.42.

23.1.3.4 For other than an autotransformer, additional overcurrent protection is not required in the primary circuit if the circuit supplying the transformer is provided with overcurrent protection rated or set at not more than 250 percent of the rated primary current of the transformer and the secondary circuit is protected by a protective device that is provided as part of the heater and is rated, or set, at not more than 15 amperes or 125 percent of the rated transformer secondary current, whichever is greater, except as noted in 23.1.3.5. See 59.39 – 59.42.

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

23.1.3.6 A required transformer overcurrent-protective device that is provided as part of a heater shall be provided for all ungrounded conductors and shall have a voltage rating not less than that of the circuit in which it is used. The device shall be:

a) A circuit breaker acceptable for branch circuit protection;

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

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

The heater shall be marked in accordance with 59.39 – 59.41.

23.2 Low-voltage transformers

23.2.1 Except as indicated in 23.2.2, a transformer having a rated output of not more than 30 volts and 1000 volt-amperes (National Electrical Code, ANSI/NFPA 70, Class 1, power-limited circuit) shall be protected by an overcurrent device located in the primary circuit. The overcurrent device shall be rated or set at not more than 15 amperes or 167 percent of the primary current rating of the transformer, whichever is greater, and shall comply with the requirements in 23.1.3.3 and 23.1.3.6.

23.2.2 A transformer that directly supplies a Class 2 circuit shall, in accordance with the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1, and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3, either limit the output current (inherently limited transformer) or be equipped with an overcurrent device (not inherently limited transformer), and need not comply with the requirements in 23.2.1.

24 Temperature Limiting Means

24.1 With respect to the conditions for Operation Tests, Section 37, and Abnormal Operation Tests, Section 41, if operation of the heater in accordance with 37.1 could result in a risk of fire or electric shock due to overheating of the heater, a thermal cutoff or a manual reset type temperature limit control shall be provided. If a manual reset type limiting control is provided, it shall be of a type that will not operate as an automatic reset control when the reset means is held in the reset position.

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

a) For a fixed heater that is ceiling mounted or is marked as stated in 59.23.

b) For a heater in which the manual reset temperature limiting control reset means or actuating member is arranged such that it:

1) Is recessed within the overall appliance enclosure,

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

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

c) For a commercial/industrial heater.

d) For a heater that complies with the following additional requirements:

1) The cycling frequency for the temperature limiting control shall be monitored and recorded for each abnormal test in which the temperature limiting control operates. The average cycle rate after each test shall be determined and shall not exceed 12 cycles per hour (at least 5 minutes per cycle).

2) During each abnormal test where combustibles are placed in contact with or very near the heater (Vertical Wall, Terry Cloth Drape, and Padded Surface), the temperature of the test material shall be measured and recorded in locations believed to represent the areas receiving the most heat from the heater such as at the discharge grill. The maximum temperatures shall not exceed 200°C (392°F) except during the first five cycles where the maximum shall not exceed 225°C (437°F).

e) For floor-insert heaters (see 32.3).

24.2 A thermal cutoff shall be secured in place. A thermal cut-off that is field-replaceable shall be used only in a commercial/industrial heater, such as a unit heater. It shall not be used in a heater intended for use in a residence.

24.3 A thermal cutoff that is field-replaceable and for use on a heater identified in 24.2 shall be so located that it will be accessible for replacement without damaging other connections or internal wiring. See 59.9.

24.4 A thermal cutoff shall open the circuit in the intended manner without causing the short-circuiting of live parts and without causing live parts to become grounded to the enclosure when the heater is connected to a circuit of voltage in accordance with 36.8 and operated in a normal position to cause abnormal heating.

24.5 To determine if a thermal cutoff complies with the requirement in 24.4, the heater is to be operated with separate cutoffs five times with any other thermally operated control devices in the heater short-circuited. Each cutoff is required to perform acceptably. During the test, the enclosure is to be connected through a 3-ampere fuse to ground.

24.6 A thermal cutoff that is depended upon to reduce the risk of fire or electric shock due to overheating of a heater during abnormal operation shall comply with the requirements in the Standard for Thermal-Links – Requirements and Application Guide, UL 60691, in addition to the requirements specified in this Standard.

24.7 With respect to 24.6, for heaters employing open-type heating elements or series-connected metal-sheathed heating elements, thermal cutoffs shall be used in all ungrounded supply conductors if the thermal cutoff in one side of the supply circuit could be rendered ineffective by faults such as shorting of the heating element or its connection wire to metal parts that are or may become grounded. In determining the likelihood of occurrence of such a fault, conditions such as sagging or breakage of an open-type heating element and breakage or loosening of the connection to a heating element are to be considered. For a 120-volt cord-connected heater with an unpolarized plug, both sides of the supply circuit are to be considered as being ungrounded.

24.8 Replacement of a field-replaceable thermal cutoff shall necessitate neither:

a) Disturbance of factory wiring other than that connected to the replaceable thermal cutoff at its terminals, nor

b) Stretching or similar displacement of the heater element wire such as to cause permanent displacement or distortion that could adversely affect the performance of the heater.

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

a) A limit control complying with the Standard for Limit Controls, UL 353, or

b) A temperature-limiting control complying with the Standard for Temperature-Indicating and Regulating Equipment, UL 873. Compliance with the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills these requirements.

See the Endurance Test, Section 42, also.

25 Alarms

25.1 A heater intended for residential use that is provided with an over-temperature limit control shall include an audible or visual alarm to indicate that the limit control has operated. See 25.2 and 25.3. The alarm shall become energized when the limit control functions to de-energize the heating elements. For an automatically-resetting temperature limiting control, when the temperature limiting control reconnects electric power to the heating element (s), the alarm may be de-energized or it may remain energized until de-energized manually. For a manual-reset temperature limiting control that operates as an automatic reset type when the reset means is held, the alarm shall remain energized until the temperature limiting control is reset.

Exception: Heaters that use the following types of temperature limit controls:

a) Manual reset type temperature limit control that will not operate as automatic reset type control when the reset means is held in the reset position. See 24.1; or

b) Thermal cutoff.

25.2 An audible alarm shall consist of a sounding device such as a buzzer, horn, beeper, or bell that generates a continuous distinct signal while it is energized. The signal shall have a frequency in the range of 700 to 3400 Hz. The alarm must have a sound level of at least 80 dBA at a distance of 2 feet in all directions (excluding the mounting or support surface- floor, wall, or ceiling). The alarm shall comply with the Alarm Device Endurance Test, Section 40.

25.3 A visual alarm shall consist of a light that is red and of a different color than the lamp used in the "power on" pilot light (see 13.6.1) or of a flashing indicator light that has an "on" time not less than one third of the "off" time and that cycles on and off at least 15 times a minute. The indicator light shall be constructed and located as specified in 13.6.1 and it shall comply with the visibility requirements in 13.6.2. The lamp used in the indicator light shall have a minimum rated life of 20,000 continuous hours at rated voltage, or it shall withstand the test specified in the Alarm Device Endurance Test, Section 40.

25.4 The "Important Instructions" furnished with a heater that includes an alarm shall include instructions in accordance with item 16 of 60.3.1.

26 Receptacles and Transfer Switches

26.1 Except as noted in 26.2, an attachment-plug receptacle for general use provided on a heater intended to be connected with other similar units to form a heating system shall not be in electrical connection with the heating-element supply terminals – that is, shall be supplied from a separate circuit.

26.2 If a combination receptacle and transfer-switch accessory is provided, the receptacle may be energized from the heater branch circuit provided that the receptacle and the heater are not connected simultaneously to the same branch circuit.

26.3 With reference to 26.2, the transfer-switch accessory shall be sized for connection to the proper size branch circuit to which the receptacle-switch combination is intended to be connected. The unit shall be marked to indicate the maximum current rating of the branch circuit to which it is to be connected.

27 Lampholders

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

27.2 Except as noted in 27.3, a lampholder shall be installed so that uninsulated live parts, other than the screw shell, will not be exposed to contact by persons removing or replacing lamps.

27.3 The requirement in 27.2 does not apply if, in order to remove or replace a lamp, it is necessary to dismantle the heater by means of tools. See 59.9.

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

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

28 Switches

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

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

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

Exception: For a ceiling-mounted heater and for a wall-mounted heater marked in accordance with 59.23, the position markings of manual controls need not be visible when the heater is installed or located as intended.

28.4 A switch (or device which serves the same purpose, such as a combination switch-thermostat, or thermostat with a positive "off" position) which is wired in the heater to interrupt the main power-supply circuit to a heater shall be on the supply side of any fuses in the heater and shall be such that, when open, it will disconnect all ungrounded conductors of the power-supply circuit if the switching device itself (or the pilot device that controls the switching device) has a marked on or off position. See 28.5 and 28.6.

Exception No. 1: Compliance with 28.4 is not necessary for a switching device which interrupts only part of the supply circuit and this is clearly indicated by a marking on the heater such as "Fan Off". However, the marking "Heat Off" or equivalent is considered to mean that the supply circuit has been fully interrupted.

Exception No. 2: Compliance with 28.4 is not required for a pilot or indicator light that is wired across the power supply circuit to indicate that the heater is still connected even though the switching device is off.

28.5 With respect to 28.4, 28.6, and 28.15, for a 120-volt rated cord-connected heater having a two-prong unpolarized attachment plug, both sides of the supply circuit are to be considered as being ungrounded.

28.6 A switching device as described in 28.4, including one that does not have a marked on or off position, shall comply with the requirement in 28.4 unless;

a) There is no uninsulated live part exposed to unintentional contact when the switching device is open, or

b) The fact that such part is live is definitely apparent, such as a visibly-glowing open coil heating element.

28.7 With respect to 28.3 and 28.4, a removable knob, button, or pointer on a switching device that includes an indicated off position shall be keyed to its operating shaft so that it can be installed only in the intended position and it shall be secured in accordance with 28.8.

28.8 A removable knob, button, or pointer mentioned in 28.7 that is attached to its operating shaft by friction and not additionally secured by mechanical means, such as a set screw, shall not separate from the intended position on its operating shaft by application of a force of 3 pounds (13.34 N) applied for 1 minute as a straight pull in line with the shaft.

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

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

28.11 A cord-connected heater shall be provided with means other than the cord and plug arrangement to manually interrupt all heating elements. This means may be either a manual on-off switch or included as an off position on a temperature regulating control or an operation selector switch. The switch or control used shall comply with 28.1 – 28.10. If included as an off position on a temperature regulating control or on an operation selector switch, the construction shall also comply with 28.12. See also 13.6.1.

28.12 With respect to 28.11, if the off position is included as part of a temperature operating control or an operation selector switch, the off position shall be mechanically defined, such as by a detent feature or as an extreme position against a mechanical stop.

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

28.14 A manually operable switch on a heater intended for permanent connection to the power supply shall be of such type or shall be so located or guarded that unintentional operation is unlikely, unless the heater is so controlled thermostatically that it will not involve a risk of fire under any operating condition.

28.15 A switch on a cord-connected heater that controls an open (uncovered) heating element or an isolated metal-clad element is a grounded heater shall be such that, in the off position, it will disconnect the element from all conductors of the supply circuit, unless the guard is such that it complies with one of the following:

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

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

28.16 The requirement in 28.15 applies to a through-cord switch and to a plug with switch comprising a part of a cord set provided with the heater or of a power-supply cord.

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

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

28.19 A switch employed in a heater to de-energize the heating elements in the event the heater is tipped over shall function before the heater has tipped in any direction beyond the angle of critical balance if compliance with the requirements in 41.5.1 – 41.5.3 is dependent on operation of the switch. The angle of critical balance is the minimum angle through which a heater must be tipped to cause it to tip over due solely to the force of gravity.

28.20 The disconnecting means of a fixed electric room heater shall have an ampere rating not less than 125 percent of the total load of the motors and the heaters and shall simultaneously disconnect the heater, motor controller(s), and supplementary overcurrent protective devices from all ungrounded conductors.

29 Automatic Controls and Control Circuits

29.1 General

29.1.1 A control circuit shall comply with the requirements for separation of circuits, 15.4.1 – 15.5.2.

29.1.2 If an auxiliary control device (thermostat or combination thermostat and control switch) in a fixed heater has a marked off position, it shall disconnect the element or elements it controls from all ungrounded conductors of the power-supply circuit when placed in that position (that is, when not cycling). See 29.1.3 and 29.1.4.

29.1.3 An auxiliary control device as described in 29.1.2, except that it does not have a marked off position, shall comply with the requirement in 29.1.2 unless:

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

b) The fact that such part is live is definitely apparent, such as a visibly-glowing open coil heating element if the heating element meets the criteria of Exception No. 1 to 13.6.1.

29.1.4 An auxiliary control device (thermostat or combination thermostat and control switch) in a cord-connected heater that controls an open (uncovered) heating element or an isolated metal-clad element in a grounded heater shall be such that, in the off position, it will disconnect the element from all conductors of the supply circuit, unless the guard is such that it complies with one of the following:

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

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

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

29.1.6 A safety control or a temperature-limiting control – one designed to prevent unintended operation of a heater – shall be operative whenever the heater is connected to its power supply and shall interrupt power to all heating elements. See 29.1.7. If there are any exposed live parts in a permanently connected heater, the operation of such a control shall disconnect the element or elements that it controls from all ungrounded conductors of the supply circuit. In a cord-connected heater, the operation of such a control shall comply with the requirement in 29.1.2. If the power to all elements is not interrupted, the power shall be interrupted to the number of the heating elements necessary so that the temperature rises specified in Table 36.1 are not exceeded during abnormal tests.

29.1.7 With respect to 29.1.6, for heaters employing open-type heating elements or series-connected sheathed heating elements, a temperature limiting control shall interrupt power to all ungrounded supply conductors if the thermal cutoff or the limiting control contacts in one side of the supply circuit could be rendered ineffective by faults such as shorting of the heating element or its connecting wire to metal parts that are or may become grounded. In determining the likelihood of occurrence of such a fault, conditions, such as sagging or breakage of an open-type heating element and breakage or loosening of the connection of a lead wire to a heating element, are to be considered. For a 120-volt cord-connected heater with an unpolarized plug, both sides of the supply circuit are to be considered as being ungrounded. More than one temperature-limiting control or thermal cutoff or combinations thereof may be used to comply with this requirement.

29.1.8 A contactor actuated by a limit control shall comply with the requirement for a limit control if it is a part of the limit-control circuit.

29.1.9 If a thermostat (or combination thermostat and control switch) has a marked position as described in 29.1.10, it shall not function as a thermostat – that is, it shall not respond to temperature changes – while the actuating member is in that position.

29.1.10 The requirement in 29.1.9 applies to a thermostat (or combination thermostat and control switch) 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.

29.1.11 A thermostat that does not reclose (remains open) when cooled to a temperature of minus 35°C (minus 31°F) is acceptable with respect to the requirement in 29.1.9.

29.2 Terminals and actuating members of safety devices

29.2.1 The terminals of a safety device within the enclosure of a heater shall be so located or further enclosed that they will be protected against unintentional short-circuiting or damage.

29.2.2 The bulb, capillary tubing, or other sensing element of a thermostat or limit switch that is depended upon to prevent the risk of fire or electric shock during operation of the heater shall be so located or guarded as to be protected from physical damage during installation and use of the heater.

29.2.3 In connection with the requirement in 29.2.2, particular attention is to be paid to a heater that, when being installed, requires partial disassembly or permits rearrangement of internal parts.

30 Spacings

30.1 Except as noted in 30.2 and 30.3, the spacings in a heater shall be in accordance with Table 30.1 and Table 30.2.

30.2 The spacings specified in Table 30.1 and Table 30.2 do not apply to the inherent spacings of a component part such as a snap switch or motor, of a heater. Such spacings are judged under the requirements for the component in question.

Table 30.1
Minimum acceptable spacings at field-wiring terminals [a,b]

Parts involved	Potential involved	Through air		Over the surface	
		Inch	(mm)	Inch	(mm)
Between live parts of opposite polarity; and between a live part and a noncurrent carrying metal part, other than the enclosure, which may be grounded	0 – 250 volts	1/4	(6/4)	3/8	(9.5)
	251 – 600	3/8	(9.5)	1/2[c]	(12.7[c])
Between a live part and the enclosure	0 – 600	1/2	(12.7)	1/2	(12.7)

[a] The spacings do not apply to connecting straps or busses extending away from wiring terminals. Such spacings are to be judged under Table 30.2.

[b] Applies to the sum of the spacings involved where an isolated noncurrent carrying part is interposed.

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

Table 30.2
Minimum acceptable spacings through air or over the surface at points other than field-wiring terminals or inside motors[a]

Parts involved	Potential involved, Volts	Inch	Millimeters
A. Between uninsulated live parts of opposite polarity; and between a rigidly mounted uninsulated live part other than an open-type heating element (see below) and a noncurrent-carrying metal part that either is exposed for persons to contact or may be grounded.	0 – 250	1/16	(1.6)
	251 – 600	1/4[b,c]	(6.4[b,c])
B. Between an open-type heating element and a noncurrent-carrying metal part that either is exposed for persons to contact or may be grounded, except for a limit control sensing element and its supports located above the heating elements[d,e,f]	0 – 600	1/2	(12.7)

[a] If an uninsulated live part is not rigidly supported, or if a movable noncurrent-carrying metal part is in proximity to an uninsulated live part, the construction shall be such that at least the minimum acceptable spacing of 1/16 inch (1.6 mm) is maintained under all

Table 30.2 Continued on Next Page

Table 30.2 Continued

Parts involved	Potential involved, Volts	Inch	Millimeters
operating conditions and under all normal conditions of handling. In applying this table, a sheath of an isolated metal-clad element in a heater with provisions for grounding is considered to be an uninsulated live part. [b] Film-coated insulated wire is considered to be an uninsulated live part. However, a spacing of not less than 3/32 inch (2.4 mm) over the surface and through air is acceptable between a noncurrent-carrying metal part and film-coated insulated wire rigidly supported and held in place on a motor coil. [c] A spacing of 1/16 inch (1.6 mm) is permissible at the heating element support and terminals only (see note d) in a heater rated for 300 volts or less. [d] These spacing requirements apply to an open-type heating element such as a ribbon type or a coiled type at locations other than the element supports and its terminal connections. At each element support and within 1/2 inch (12.7 mm) of the support, measured from the outer edge of the support point along the heater element, and at the terminal connections, the spacings specified in item A apply provided the element supports are constructed such that sagging of the heating element due to loss of its tension will not result in reduction of the minimum spacings as specified in item A. [e] For the limit control sensing element and its supports located above the heating element, the spacing requirements in item A apply. A limit control sensing element and its supports are considered to be above the heating element if any sag in the heating element due to gravity would result in an increased spacing between the heating element and the limit control sensing element or its supports. [f] Less than a 1/2-inch spacing between the open-type heating element and a noncurrent carrying metal part, but not less than the spacing specified in item A, is acceptable if the design of the heating element and its supports is such that sagging or movement of the heating element, to reduce the spacing to less than specified in item A, is not likely to occur.			

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

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

30.5 Except as indicated in 30.6, an insulating lining or barrier of fiber or similar material employed where spacings would otherwise be less than the required values shall not be less than 1/32 inch (0.8 mm) thick and shall be so located or of such material that it will not be affected adversely by arcing; except that fiber not less than 1/64 inch (0.4 mm) thick may be used in conjunction with an air spacing of not less than 50 percent of the spacing required for air alone.

30.6 Insulating material having a thickness less than that specified in 30.5 may be used if, upon investigation, it is found to be acceptable for the application.

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

31 Grounding

31.1 In a heater intended for permanent connection to the power-supply circuit, all exposed dead metal parts and all dead metal parts inside the enclosure that are exposed to contact during any servicing operation (including maintenance and repair) and that are likely to become energized shall be electrically connected to the equipment-grounding terminal or lead and be conductively connected to the point of attachment of the wiring system.

31.2 In a heater intended for permanent connection to the power supply by means other than a metal-enclosed wiring system (such as nonmetallic-sheathed cable):

a) An equipment-grounding terminal or lead shall be provided (see 13.1.25 and 13.1.28), and

b) All exposed noncurrent-carrying metal parts and all noncurrent-carrying metal parts inside the enclosure that are exposed to contact during any servicing operation (including maintenance and repair) and that are likely to become energized shall be conductively connected to such terminal or lead.

31.3 The resistance of the grounding path between a dead metal part and the equipment-grounding terminal and point of attachment of the wiring system shall not be more than 0.1 ohm.

31.4 With reference to 31.3, the resistance may be determined by any convenient method except that when referee measurements are necessary, either a direct or alternating current at a potential of not more than 12 volts, and equal to the current rating of the maximum-current-rated branch-circuit overcurrent-protective device that may be employed with the heater is to be passed from the equipment grounding terminal or the point of attachment of the wiring system or the grounded blade of the attachment plug to the dead metal part, and the resulting drop in potential in volts divided by the current in amperes passing between the two points is to be calculated to obtain the resistance.

31.5 A cord-connected heater intended for operation on a circuit involving a potential of more than 150 volts to ground shall have provision for grounding, in accordance with 31.6 (except as indicated in 31.9), of all exposed noncurrent-carrying parts, and all noncurrent-carrying metal parts exposed during any servicing operation (including maintenance and repair), that are likely to be energized.

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

a) Green, with or without one or more yellow stripes,

b) Connected to the grounding blade of an attachment plug of a grounding type, and

c) Connected to the enclosure of the appliance by means of a screw not likely to be removed during ordinary servicing, or by other equivalent means. Solder alone is not acceptable for making this connection. See 31.8.

31.7 If a cord-connected heater intended for operation on a circuit involving a potential of 150 volts or less to ground has provision (although not required) for grounding noncurrent-carrying metal parts by means of a conductor of the cord, a directly attached flexible cord or a cord set provided with the heater shall comply with the requirement in 31.6.

31.8 With reference to 31.6 (c), a grounding connection that is mechanically crimped before being soldered is to be tested for acceptability as a connection without the solder in place.

31.9 With reference to the requirements in 31.1 and 31.2, the sheath of an isolated metal-clad element in a heater having provision for grounding is not considered to be a noncurrent-carrying metal part (see note a to Table 32.2) and, therefore, is not to be grounded.

31.10 A cord-connected, 2-wire heater, having a voltage rating within the range of 220 to 250 volts is considered as requiring provision for grounding in accordance with 31.5, unless the marked rating on the heater is 120/240 volts or unless the heater is otherwise marked to indicate that it is to be connected only to a 120/240-volt circuit with circuit with grounded neutral.

32 Guarding of Heating Elements

32.1 General

32.1.1 Except as noted in 28.15 and 32.1.2, the heating element and any part of the element assembly (such as an element support, sheath, and the like) shall be so guarded that flammable material as well as persons will be protected against contacting it.

32.1.2 The requirement in 32.1.1 does not apply to a heater intended for mounting in a location (in a ceiling, for example) such that there is no likelihood that furniture, draperies, and the like will contact it; the need for and the acceptability of the guard on such a heater is judged on the basis of the design and construction of the heater. See 59.23.

32.1.3 The acceptability of a guard is judged with respect to its general serviceability and with respect to the shape and size or both of the openings in it, in conjunction with the distance of the guard from the heating element and the other high-temperature parts mentioned in 32.1.1. Except as noted in 32.1.5, an opening in a guard is considered to be acceptable if, with the heater in any intended operating position, the following conditions are met:

a) The shape and size of an opening are such that a test gauge in the form of a right-circular cone having a base diameter of 2-3/4 inches (69.9 mm) and an altitude of 5-1/2 inches (139.7 mm) is prevented from touching the heating element and the other high-temperature parts mentioned in 32.1.1 when the gauge is inserted, apex first, in any manner. See 32.1.4.

b) The shape and size of an opening which permits the vertically downward entrance of a bar 1/2 inch wide (12.7 mm) and 1/16 inch thick (1.6 mm) are such that a test gauge 1/16 inch (1.6 mm) thick and in the form of an isosceles triangle having a base of 2-3/4 inches (69.9 mm) and an altitude of 5-1/2 inches (139.7 mm) is prevented from touching the heating element and the other high-temperature parts mentioned in 32.1.1 when the gauge is inserted, apex first, in any manner. The testing of an opening with the triangle gauge applies also where the vertically downward insertion of the bar is prevented by the construction of the guard, the use of an additional barrier, or both, unless the vertically applied bar tends to be deflected outward – that is, away from the guard.

c) The area of an opening in a substantially vertical face of a guard is not more than 3-1/4 square inches (2100 mm^2) if the size and/or shape of the opening permits the entrance from any horizontal direction of a vertical rod 1/16 inch (1.6 mm) in diameter and 2-3/4 inch (69.9 mm) long.

32.1.4 The fins of a metal-clad element are considered to be element-guarding members, and need not comply with the provisions in 32.1.3(a) if the temperature of the exposed edges (outer perimeter) of the fins is not more than 280°C (536°F).

32.1.5 Openings in the guard complying only with 32.1.3(a) are acceptable for the following:

a) Except for a panel-type heater (see 32.2.1), an air heater in which the temperature of the heating element is not higher than 280°C (536°F) under conditions of intended operation, or

b) A fan-type heater in which the fan is always in operation when the heating element is on (energized) and the air current prevents clothing and the like from entering the guard.

32.1.6 If a heater is required to have a guard, and if the guard is readily removable, the heater and the guard shall be contained in the same carton as shipped from the factory. See also 59.30.

32.1.7 A heater in which the heating element is designed for operation only in an air current shall be so wired or controlled that the element can be operated only when under the cooling effect of the air stream.

A heater in which the cooling effect of the motion of a part is necessary to prevent excessive temperatures shall be so wired or controlled that the element cannot be operated without such motion.

32.2 Panel-type heaters

32.2.1 Except as noted in 32.2.2, a panel-type heater shall be provided with a guard that will prevent a test surface, in the form of a 6-inch square (a square 152 mm on a side) parallel to the element panel, from being brought closer than 1/2 inch (12.7 mm) to the plane of the front of the heater, excluding the guard.

32.2.2 The requirement in 32.2.1 does not apply to:

a) A heater as described in 32.1.2.

b) A heater having an element panel operating at a temperature higher than 280°C (536°F) and required by 32.1.1 and 32.1.3 to have more effective guarding.

c) A heater that will not cause glowing or flaming of the cheesecloth or the felt when subjected to a blanketing test in which one or more 1-inch-thick (25 mm) felt pads, covered with cheesecloth, are rigidly supported on a wood surface in intimate contact, as far as possible, with all external heated surfaces while the heater is operated until ultimate results are observed.

32.3 Floor heaters

32.3.1 A floor-insert heater shall be so constructed as to facilitate cleaning and to minimize the possibility of the accumulation of combustible dirt and litter where it might become ignited.

32.3.2 A heater intended to be installed flush with or beneath a floor shall be provided with an automatic temperature control other than a thermal cutoff. The control shall comply with the requirements in 29.1.2 – 29.2.1, 42.1 and 42.2.

32.3.3 When a floor insert heater register that is nonmetallic or has a nonmetallic coating is judged for acceptability in accordance with 7.1, 49.1, and item 18 of Table 36.1, and thermal aging, the following factors are to be taken into consideration:

a) Resistance to wear.

b) Resistance to impact.

c) Moisture-absorptive properties.

d) Combustibility.

e) Resistance to corrosion.

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

32.3.4 There shall be no openings in wiring compartments through which objects such as nails, pin, and the like may penetrate and contact uninsulated live parts.

PERFORMANCE

33 General

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

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

Exception No. 2: The requirement for tests with the legs or base detached is not applicable to a heater that is marked in accordance with 59.37.

34 Power Input Test

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

34.2 To determine if a heater complies with the requirement in 34.1, the power input is to be measured with the heater at the temperature developed under intended operating conditions and under full-load conditions and while connected to a supply circuit of rated voltage in accordance with 36.8. If a heater employs a nonmetallic element (such as carbon), the power input is to be determined when the element is new.

35 Leakage Current Test

35.1 The leakage current of a cord-connected heater rated for a nominal 120-, 208-, or 240-volt supply when tested in accordance with 35.3 – 35.6 shall not be more than:

a) 0.5 milliampere for a portable heater, and

b) 0.75 milliampere for other than a portable heater employing a standard attachment plug rated 20 amperes or less.

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

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

35.3 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from the surfaces are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible and from one surface to another where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure considered acceptable for protection against the risk of electric shock as defined in 7.1 – 7.26. Surfaces are considered to be simultaneously accessible where they can be contacted by one or both hands of a person at the same time. These measurements do not apply to terminals operating at voltages which are considered to be nonhazardous.

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

35.5 The measurement circuit for leakage current is to be as shown in Figure 35.1. The measurement is defined in (a) – (d) below. The meter which is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used need not have all the attributes of the defined instrument.

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

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

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

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

35.6 A sample of the heater is to be tested for leakage current starting with the as-received condition with all switches and thermostats closed, but with its grounding conductor, if any, opened at the attachment plug. The as-received condition is without prior energization, except as may occur as part of the production line testing. The supply voltage is to be 120, 208, or 240 volts, depending upon the voltage rating of the heater. The test sequence, with reference to the measuring circuit (Figure 35.1), is to be as follows:

a) With switch S1 opened, the heater is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2.

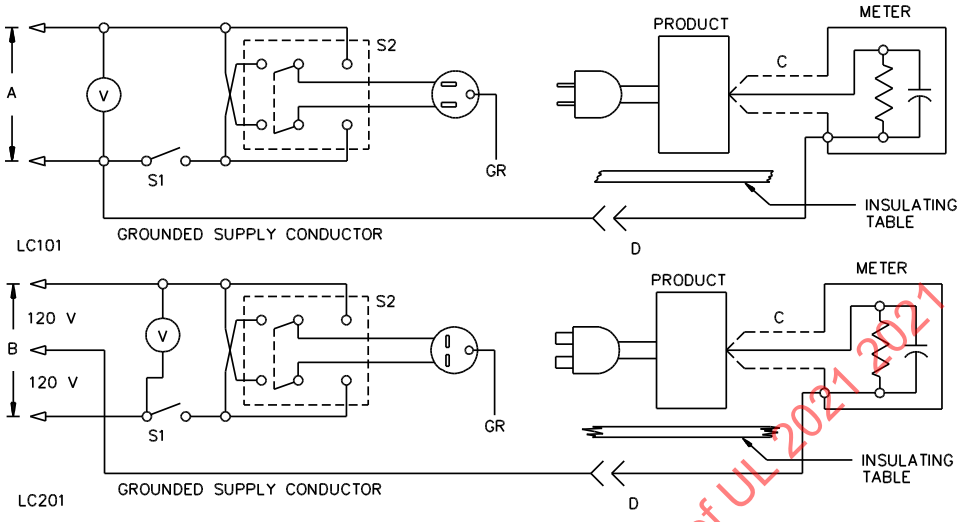
b) Switch S1 is then to be closed, energizing the heater, and within a period of 5 seconds, the leakage current is to be measured using both positions of switch S2 and with the heater operated at the maximum heat setting of controls.

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

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

Figure 35.1

Leakage-current measurement circuit



A. Product intended for connection to a 120 or 280 volt power supply.

B. 240 or 208 volt product intended for connection to a 3-wire, grounded neutral power supply, as illustrated above.

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

D. Separated and used as clip when measuring currents from one part of a product to another.

36 Normal Temperature Tests

36.1 A heater, when tested under the conditions described in 36.2 – 36.13 shall not attain a temperature at any point high enough to constitute a risk of fire or damage any material employed in the heater, nor show temperature rises at specific points greater than those indicated in Table 36.1.

36.2 All values in Table 36.1 are based on an assumed ambient (room) temperature of 25°C (77°F), but a test may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F). However, if the operation of a thermal control or thermal cutoff during the test limits the temperatures under observation, no observed temperature higher than 25° C (77° F) plus the specified maximum rise is acceptable.

Table 36.1
Maximum acceptable temperature rises

	Materials and component parts	Degrees	
		C	F
1.	Any point within a terminal box or wiring compartment of a permanently connected heating appliance in which field-installed conductors are to be connected (including such conductors themselves) unless the appliance is marked in accordance with 59.13	35	63
2.	Any point on a surface adjacent to a fixed heater (including the surface on which the heater is mounted) specified points on test surfaces and enclosures at designated clearances from the heater, a metal surface of a heater at the point of contact with the test surface, and the exterior surface of a recessed heater that may come into contact with combustible material within the test enclosure	65	117
3.	Fuses[a]	65	117
4.	Fiber used as electrical insulation or as cord bushings	65	117
5.	Wood or other combustible material which is part of the heater	65	117
6.	Cotton or rayon braid of a flexible cord	65[b]	117[b]
7.	Class 105 insulated relay or solenoid winding	65[c]	117[c]
8.	Class A insulation system on coil windings of an a-c motor having a frame diameter (see note d) of more than 7 inches (178 mm) and of a d-c or universal motor[d]:		
	a. In an open motor:		
	Thermocouple method	65	117
	Resistance method	75	135
	b. In a totally enclosed motor:		
	Thermocouple method	70	126
	Resistance method	80	144
9.	Class A insulation systems on coil windings or a-c motor (not including a universal motor) having a frame diameter (see note d) of 7 inches (178 mm) or less and on a vibrator coil – thermocouple or resistance method[c]:		
	a. In open motor and on a vibrator coil	75	135
	b. In a totally enclosed motor	80	144
10.	Class 130 insulation systems except as indicated in items 11 and 12		
	Thermocouple method[c]	85	153
	Resistance method	105	189
11.	Class B insulation system on coil windings of an a-c motor having a frame diameter (see note d) of more than 7 inches (178 mm) and of a d-c or universal motor[e]		
	a. In an open motor:		

Table 36.1 Continued on Next Page

Table 36.1 Continued

Materials and component parts		Degrees	
		C	F
	Thermocouple method[b]	85	153
	Resistance method	95	171
	b. In totally enclosed motor:		
	Thermocouple method	90	162
	Resistance method	100	180
12.	Class B insulation system on coil windings of an a-c motor (not including a universal motor) having a frame diameter (see note d) of 7 inches or less and on vibrator coils – thermocouple or resistance method[e]:		
	a. In open motors and on vibrator coils	95	171
	b. In totally enclosed motors	100	180
13.	Phenolic composition used as electrical insulation or where degradation would result in a risk of fire or electric shock condition[f]	125	225
14.	Insulated wire or cord	25°C (45°F) less than its temperature rating[g]	
15	Sealing compound[h]		
16.	Copper conductor, bare or insulated, without tinning, nickel coating, or silver plating, except as noted in item 17	175	315
17.	Termination of copper conductor in a pressure terminal connector:		
	a. Terminal and/or conductor unplated	125	225
	b. Terminal and conductor tinned, nickel-coated, or silver-plated	175	315
18.	Register temperatures floor insert heater:		
	a. Metal grill[f]	44	80
	b. Nonmetallic grill[f]	50	90
19.	Points on handles, switches, and control knobs and buttons likely to be contacted by the user during normal operation, and the surfaces likely to be contacted by hands or fingers in grasping handles, switches, and control knobs and buttons[i]:		
	a. Metal	35	63
	b. Nonmetallic[i]	60	108
20.	Power diode case (body)	k	k

[a] Includes both casing and ferrule. However, a temperature not more than 20°C (36°F) higher than the values indicated in the Table is acceptable on the casing (not the ferrule) of a Class G, J, or T fuse.

[b] Inside a heater, the braid of a heater cord may be subjected to a greater rise if the inorganic fiber insulation is held in place by other acceptable means.

[c] A maximum rise of 85°C (153°F) is acceptable by the resistance method.

[d] This is the diameter, measured in the plane of the laminations, of the circle circumscribing the stator frame, excluding lugs, fins, boxes, and the like, used solely for motor mounting, cooling, assembly, or connections.

[e] See 36.6 and 36.7.

[f] The limitation on phenolic composition does not apply to a compound which has been investigated and found to have heat-resistant properties.

[g] Inside a heater, the temperature rise on a wire or cord may be greater than the specified maximum rise provided that the insulation on each individual conductor is protected by supplementary insulation (such as a braid, wrap, tape or close-fitting tubing) which is acceptable for the temperature and type of insulation involved.

[h] Unless a thermosetting material, the maximum sealing-compound temperature, when corrected to a 25°C (77°F) ambient temperature is 15°C (27°F) less than the softening point of the compound as determined by the Standard Test Method for Softening Point by Ring-and-Ball Apparatus, ASTM E28-96.

Table 36.1 Continued on Next Page

Table 36.1 Continued

Materials and component parts	Degrees	
	C	F
[i] Surfaces likely to be contacted are considered to be those within 1-1/2 inches (38 mm) of the gripping surface of a knob or button, measured in the same plane as the surface on which the knob or button is mounted, except that the surface behind the knob or button is not considered likely to be contacted if: 1) The knob or button is at least 1 inch (25.4 mm) long, including the shaft extension, or 2) If a knob or a button less than 1 inch long is provided with a skirt or flange at the base of its gripping surface that is at least 1/4 inch (6.4 mm) wide. The gripping surface for a carrying handle is considered to be 4 inches (102 mm) wide, and surfaces likely to be contacted are considered to be those within 1-1/2 inch, in any direction of the gripping surface of the handle. Points and surfaces guarded by a barrier that is at least 5/8 inch (15.9 mm) wide are not considered likely to be contacted provided the temperature rise of the barrier does not exceed the required values. [j] A knob, handle, or button made of nonmetallic material that is plated or clad with metal having a thickness of 0.005 inch (0.13 mm) or less and a metal knob, handle, or button having a plastic or vinyl covering of not less than 0.005 inch thickness is to be judged as a nonmetallic part. [k] This temperature rise on a power diode shall not exceed the difference between the ambient and the temperature rating specified for the diode by the diode manufacturer. If no temperature rating is specified for the power diode, the maximum acceptable temperature rise shall not exceed 65°C (117°F).		

36.3 Temperatures are to be measured by thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm) except that a coil temperature may be determined by the change-of-resistance method if the coil is inaccessible for mounting thermocouples (see 36.6). If thermocouples are used in determining temperatures in electrical equipment, it is standard practice to employ thermocouples consisting of 30 AWG (0.05 mm^2) iron and constantan wire and a potentiometer-type instrument; and such equipment is to be used whenever referee temperature measurements by thermocouple are necessary.

36.4 A temperature is considered to be constant when three successive readings, taken at intervals of 10 percent of the previously elapsed duration of the test (but not less than 5-minute intervals), indicate no change. The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice. The thermocouple wire is to conform with the requirements 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, ANSI/ASTM E230/E230M.

36.5 A thermocouple junction and adjacent thermocouple lead wire are to be securely held in good thermal contact with the surface of the material whose temperature is being measured. In most cases, acceptable thermal contact will result from securely taping or cementing the thermocouple in place but, if a metal surface is involved, brazing or soldering the thermocouple to the metal may be necessary. See also 38.16.

36.6 Ordinarily a thermocouple is to be used for determining temperature of a coil or winding if it can be mounted, without removal of encapsulating compound or the like 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 1/32 inch (0.8 mm) thick and consists of cotton, paper, rayon, or the like.

The change-of-resistance method is to be used if the thermocouple measurement cannot be conducted in accordance with the foregoing considerations. For a thermocouple-measured temperature of a motor coil the thermocouple is to be mounted on the integrally applied insulation of the conductor.

36.7 At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature rise measured by means of a thermocouple may be higher by the following amount than the maximum indicated in Table 36.1 if the temperature rise of the coil measured by the resistance method is not greater than specified in Table 36.1:

	Items in Table 36.1	Additional thermocouple rise
Item 7 and	part of item 8	15°C (27°F)
	part of item 9	5°C (9°F)
	part of item 11	20°C (36°F)
	part of item 12	10°C (18°F)

36.8 To determine whether a heater complies with the requirement in 36.1, it is to be operated continuously until constant temperatures have been reached. The test voltage is to be as indicated in Table 36.2, except that, if the application of the indicated test voltage does not result in the measured wattage input to the heater being equal to or more than the marked wattage rating, the test voltage is to be increased until the measured wattage input equals the marked wattage rating.

Table 36.2
Voltage for temperature test[a]

Marked voltage rating	Test potential in volts
Value within one if the specified ranges	Highest value of corresponding specified ranges
Value not within one of the specified ranges	Rated voltage

[a] Specified range refers to any of the ranges of voltage mentioned in 58.1.

36.9 With reference to 36.8, a heater shall be operated at the maximum rated input. However, for a heater that employs adjustable controls for heater or fan settings, tests at lower heater and fan settings shall also be conducted if the lower settings may produce higher temperatures on heater parts or the test enclosure.

36.10 If a heater employs a motor in addition to a heating element, the voltage applied to an integrally connected motor is to be the marked voltage rating of the heater, in accordance with 58.1. A motor supplied from a separate circuit is to be operated at a voltage (depending upon the motor rating) as specified for an integrally connected motor.

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

36.12 Temperatures on the register of floor insert heaters are to be obtained after equilibrium outlet air temperatures are attained. Surfaces of the register, in an essentially horizontal plane, and likely to be contacted by a person walking or falling upon the grill are then to be explored with a surface pyrometer to determine the single point attaining the highest temperature rise. The thermocouple is then to be attached at this point and this temperature is to be recorded until an equilibrium temperature condition is attained. See item 18 of Table 36.1 for the applicable temperature rise limit.

36.13 Whenever cheesecloth is mentioned in connection with either a normal- or an abnormal-temperature test, the cloth is to be bleached cheesecloth 36 inches wide (914 mm), running 14 – 15 yards

per pound mass (approximately 28 – 30 m/kg mass), and having what is known to the trade as a count of 32 x 28 – that is, for any square inch, 32 threads in one direction and 28 threads in the other direction (for any square centimeter, 13 threads in one direction and 11 threads in the other direction).

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

36.15 The white duck material (cotton) mentioned in this Standard is to have a mass of 8 ounces per square yard (0.27 kg/m^2).

36.16 The felt mentioned in this Standard to be 100 percent standard-weight, all-cattle-hair, punched felt with center reinforcement consisting of burlap having a mass of 5 ounces per square yard (.17 kg/m^2). Felt 1 inch (25 mm) thick has a mass of 105 ±0.51 kg/m^2). Felt 3/4 inch (19 mm) thick has a mass of 79 ±9 ounces per square yard (2.68 ±0.31 kg/m^2).

Exception: SAE J314, Grade F-11, minimum 1 inch (25 mm) thick wool felt may be used as a substitute for the all-cattle-hair mat.

36.17 See 39.1 for description of terry cloth material mentioned in this Standard.

37 Conditions for Operation Tests

37.1 The contacts of the following controls shall be shunted out of the circuit during the Continuous Operation Test, Section 38, and the Abnormal Operation Tests, Section 41, except as specified in the Exception to 41.7.3. The tests are conducted while the controls are in the circuit and while the controls are out of the circuit.

a) A temperature regulating control.

b) A combination temperature regulating and limiting control.

c) A temperature limiting control whose operation is affected by the temperature of the ambient air surrounding the heater such that risk of fire may result, unless the heater is subjected to the cold room tests specified in 37.2.

d) An automatic reset temperature limiting control unless the heater complies with the exception to 24.1.

e) A manual reset type temperature limiting control that operates as an automatic reset type when the reset means is held in the "reset" position, unless the heater complies with the exception to 24.1.

f) Any thermally actuated control which operates during the Continuous Operation Test, Section 38.

Exception: Any thermally actuated control that operates when testing up against the wall in accordance with 38.14 need not be shunted out of the circuit if the test of 38.15 is conducted.

37.2 With respect to 37.1(c), a temperature-limiting control need not be shunted out of the circuit if all of the abnormal operation tests (drape, band drape, tip over, vertical wall, blanketing, padded surface, and the like, usually performed on the heater) are repeated while the heater is located in a room having an average temperature of 0°C (32°F).

37.3 The temperature limiting control of a heater shall not function when the heater is operated under the Normal Temperature Test, at room ambient temperature. A room ambient temperature of 25°C (77°F) is

assumed, but the test may be conducted at a higher ambient temperature provided the temperature limiting control does not operate (open circuit).

37.4 With respect to 24.1, a tip-over switch that actuates the contacts of a temperature-regulating control, or the contacts of a combination temperature-regulating and -limiting control, shall be rendered inoperative during abnormal tests, including the tip-over test, 41.5.1 – 41.5.3 and during the Element Support Impact Tests, Section 51.

37.5 Unless marked in accordance with 59.23 or 59.29, a permanently connected wall-mounted air heater or a portable cord-connected wall-mounted air heater is to be located as close to the floor as possible during all tests.

38 Continuous Operation Test

38.1 A permanently connected wall-mounted air heater and a heater intended to be mounted to an outlet box in a wall are to be supported in the intended manner on the black-painted surface of a wall consisting of 3/8-inch-thick (9.5 mm) plywood fastened to both shorter sides of nominal 2- by 4-inch (38- by 89-mm) vertical wooden studs on 16-inch (406 mm) centers. Two or more such walls are to be fastened together to form a 90-degree angle, and the height and length of the walls are to be such that they extend not less than 2 feet (610 mm) beyond the physical limits of the heater. A ceiling surface is to be added consisting of 3/8-inch (9.5-mm) plywood. The heater is to be located as close to the sides of the wall angle as its construction will permit, and it is to be placed relative to the walls that maximum heating will occur on the latter; except that it may be spaced away from the sides of the wall angle to prevent the attainment of temperature rises of more than 65°C (117°F) thereon if the heater is marked as described in 59.22.

38.2 Heaters intended to be mounted on the wall at or near ceiling height shall be tested in the corner as close to the side walls and ceiling as construction will permit unless it is marked in accordance with 59.22.

38.3 A cord-connected wall mounted air heater is to be installed in the same manner as described in 38.1 except no consideration is to be given to the clearance marking described in 59.22.

38.4 In addition, an individual wall-insert heater is to be mounted in a box-like structure of 3/8-inch (9.5 mm) plywood or the equivalent with the internal dimensions such that the walls make a close fit with the heater shell on the four sides and rear (but the walls of the box are to be perpendicular to its back) and having a flat front surface simulating the wall surface in which the heater is designed to be mounted. The assembly of the heater and the plywood box is to be mounted in an appropriate opening in the wall mentioned in 38.1.

38.5 A ceiling-mounted air heater and a heater intended to be supported by an outlet box located in the ceiling are to be tested in an alcove consisting of the walls described in 38.1, with an added ceiling surface of 3/8-inch (9.5-mm) plywood blanketed on top with 4 inches (100 mm) of conventional glass-fiber or mineral-wool insulation having a minimum R factor of 12 or insulation of lesser thickness having a minimum R factor of 12. The heater is to be mounted on or in the ceiling surface as close to the alcove corner as its physical dimensions will permit unless it is marked in accordance with 59.22.

38.6 If the ceiling-mounted heater mentioned in 38.5 is of the insert type, its mounting is to include a boxlike structure similar to that described in 38.4, together with the insulation mentioned in 38.5. The insulation is to be placed adjacent to all outer surfaces of the boxlike structure.

38.7 Ceiling panel-type heaters that are intended to be mounted in multiples in such manner that large areas of the ceiling surface are covered by the heating units are to be applied to the ceiling surface as described in 38.5. No fewer than four heaters are to be used and they are to be mounted as close to the corner and to each other as their physical dimensions will permit, unless the manufacturer's instructions that accompany each heating unit specify otherwise and the heaters are marked in accordance with 59.22.

38.8 The ceiling panel-type heaters mentioned in 38.7 are to be connected to the source of supply and interconnected to each other in the manner prescribed in the manufacturer's instructions, making use of any special fittings supplied with each panel unit.

38.9 A ceiling panel-type heater intended to be mounted individually or in multiple in a dropped ceiling installation (supported by T-bars) is to be supported in the intended manner as described in the manufacturer's instructions while positioned in an alcove in the manner described in 38.5.

38.10 The continuous-operation test on an industrial ceiling- or wall-mounted quartz-lamp or similar heater is to be conducted as follows. In the absence of a marking as described in 59.35, the test is to be conducted first with three samples of the heater mounted end-to-end, and is to be repeated with the three samples mounted side-by-side. In each case the samples are to be mounted as close together as their configuration permits, and temperatures are to be measured on the center sample. If the marking described in 59.35 indicates that the heater is to be separated by no more than 3 feet (0.91 m) from adjacent heaters, the test is to be conducted as described above, but with adjacent samples separated in accordance with the marked mounting instructions. If the marking indicates that the heater is to be separated by more than 3 feet (0.91 m) from adjacent heaters, the test is to be conducted on a single sample, without other samples in proximity thereto.

38.11 Unless it has been determined that it will remain in position during the handling of the heater prior to and during installation and after the heater has been installed, external thermal insulation (such as mats of woven glass fiber or mineral wool) is to be removed from the heater before it is installed in or on the surfaces of the test enclosure.

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

38.13 If the removal of feet or other supports results in operation of protective devices during the Continuous Operation Test, Section 38, such operation is not considered to be unacceptable if, when the test is repeated with the parts replaced in the intended manner, there is no operation of the protective devices.

38.14 A floor-supported heater is to be supported on two layers of white tissue paper on a softwood surface and placed in a corner alcove as described in 38.1. The heater is to be placed as close to the side walls of the alcove as its configuration will permit. If a safety control operates when the heater is in such position, it is to be moved away from the side walls by the minimum distance necessary to prevent such operation.

38.15 If the Exception to 37.1(f) is to be applied, the test in 38.14 is to be conducted while the product is tested up against the wall and operating under its thermally actuated control.

38.16 With reference to the requirements in 36.1 – 36.6, temperatures are to be measured by thermocouples attached to the metal of the heater enclosure.

39 Terry Cloth Test Fabric

39.1 The terry cloth material used in the tests described in 41.6.1, 41.7.1, 41.7.3 – 41.7.6, and 41.8.2 shall be white, basically cotton terry cloth untreated fabric with a polyester content not more than 20 percent, and having a pile weave and a nominal weight of 8 ounces per square yard (270 g/m^2).

40 Alarm Device Endurance Test

40.1 With regard to 25.1 and 25.2, an audible alarm device shall withstand without malfunction or breakdown, an endurance test consisting of 6000 cycles of operation at the rate of 1 minute on and 30 seconds off. The test is to be conducted at rated voltage and at the maximum ambient temperature determined during the Normal Temperature Tests, Section 36.

40.2 With regard to 25.1 and 25.3, a visual alarm device shall withstand without burning out or failing to light, an endurance test consisting of 6000 cycles of operation at the rate of 1 minute on and 30 seconds off. The test is to be conducted at the rated voltage and at the maximum ambient temperature determined during the Normal Temperature Tests, Section 36.

41 Abnormal Operation Test

41.1 General

41.1.1 If the conditions of normal operation are not representative also of abnormal conditions likely to be obtained in actual service, a heater shall not become a risk of fire, electric shock or personal injury when operated continuously under such abnormal conditions. The applied voltage and method of mounting shall be in accordance with 36.8 – 36.12.

41.1.2 To determine whether risk or fire actually exists, a separate burnout or abnormal-heating test is to be conducted with the heater operating continuously until the ultimate result has been determined. In most cases, continuous operation for 7 to 8 hours will be necessary in order to prove that the ultimate result has been observed. A cord-connected heater is to be placed on white tissue paper on a softwood surface.

41.1.3 For the abnormal operation tests, a heater is to be operated at the maximum rated input. However, for a heater that employs adjustable controls for heater or fan settings, tests at lower heater and fan settings shall also be conducted if the settings influence operation of a limit control that operates during any abnormal operation test.

41.1.4 When operated under such abnormal conditions, a heater is considered to involve a risk of fire if there is any emission of flame or molten metal or if there is glowing or flaming of the combustible material upon which the heater is placed or, in the case of a permanently installed heater, of combustible material that is in proximity to the device as installed.

41.1.5 After having been subjected to an abnormal test, a cord-connected heater is considered to involve a risk of electric shock if:

a) It appears to be usable, and

b) The insulation resistance is less than 50,000 ohms.

41.2 Abnormal motor temperature test

41.2.1 If a motor is connected across a portion of a resistance element, an open circuit in that portion of the element that is in parallel with the motor shall not result in a risk of fire and there shall be no emission of flame or molten metal. See 41.2.2 – 41.2.5.

41.2.2 Compliance with 41.2.1 is to be determined by testing three samples of the heater. The samples are to be tested in accordance with the conditions specified in Conditions for Operation Tests, Section 37, and Continuous Operation Test, Section 38, or as described in 41.2.5. The heating element connected in parallel with the motor is to be open-circuited (see 41.2.4) and two layers of cheesecloth are to be draped

to cover all air inlet and outlet openings of the heater. The heater is to be energized at the rated voltage and operated continuously until either motor burnout or stabilized motor temperature occurs.

41.2.3 With respect to 41.2.2, any of the results listed in (a) – (c) are considered to comply with 41.2.1:

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

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

c) If no burnout or no operation of a thermal protector occurs, the operation is to be continued until the temperatures stabilize. The temperature rise of the motor winding shall not exceed the rise specified in Table 36.1 for the motor coil.

Exception: If the temperature rise of the motor exceeds the rise specified in Table 36.1, the operation is to be continued for 15 days and temperatures are to be monitored. The measured temperatures shall not exceed the temperature limits for locked rotor conditions specified in UL 2111, as applicable.

41.2.4 For a heater that includes more than one heating element in parallel with the motor, the test described in 41.2.1 is to be conducted by first opening one of the elements. If the opening of one element does not manifest itself in the heater operation, the temperature of the motor windings shall not exceed the limits specified in Table 36.1 and the test shall be repeated with other elements in parallel with the motor opened.

41.2.5 At the manufacturer's option, certain motor or motor and thermal protector combinations as described in (a) and (b) can be tested as specified in 41.2.2 and 41.2.3 except independent of the heater. The test voltage is to be that to which they will be subjected if the parallel-connected heating element opens. During the test, two layers of cheesecloth are to be draped over the motor and there shall be no ignition of the cheesecloth when the motor open-circuits and no emission of molten or flaming particles.

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

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

41.3 Stalled fan

41.3.1 A heater that employs a motor-driven air circulating fan shall not:

a) Emit sparks, flames, or molten metal,

b) Become damaged to the extent that it becomes a risk of fire or electric shock (see 41.3.2), or

c) Open a nontime-delay 1/2-ampere fuse, when subjected to the test in accordance with 41.3.3 – 41.3.5.

41.3.2 With respect to 41.3.1(b), a risk of electric shock is considered to be present if after this test the heater does not comply with the requirements in Enclosure, Section 7.

41.3.3 A heater is to be installed or located in accordance with the Continuous Operation Test, Section 38. A 1/2-ampere fuse of other than the time-delay type is to be connected between the accessible dead metal parts (see 51.10) of the heater and the earth ground. The grounded conductor and a grounding conductor, if provided, are to be treated as described in 51.3.

41.3.4 The fan motor is to be stalled and the heater is to be operated at rated voltage and maximum rated input for 7 hours unless a manual reset type limit control or a thermal cut-off operates to de-energize either all or a sufficient number of heating elements so that there is no longer a risk of fire or development of an electric shock – see 41.3.2.

41.3.5 For a heater that employs adjustable heat setting controls, this test shall also be conducted at other than maximum rated input if the other settings influence operation of a limit control.

41.4 Overvoltage test

41.4.1 A heater shall be capable of operating for 2 hours without presenting a fire risk while connected to a supply circuit having a potential 12 percent more than the rated voltage of the heater.

41.4.2 In determining whether a heater complies with the requirement in 41.4.1, it is to be operated at a voltage in accordance with 36.8 until constant temperatures are attained, following which it is to be operated for 2 hours at a 12 percent higher voltage.

41.5 Tip over

41.5.1 Unless it is fastened to the wall or ceiling, a cord-connected heater overturned in any position on a softwood surface covered with a single layer of terry cloth shall not cause the cloth or wood to glow or flame.

41.5.2 To determine if a heater complies with the requirement in 41.5.1, it is to be operated under the most severe conditions that would result when it comes to rest, without further guiding or propping, after having been pushed over.

41.5.3 With reference to 41.5.2, the most severe condition is the one where the heating element and reflector face downward. However, other orientations, such as the heater resting on its side, are also to be tested.

Exception: If a given orientation or position of the heater presents less likelihood of glowing or flaming of the cloth or wood than when the heater is evaluated in accordance with other requirements in the standard, the orientation or position need not be reevaluated under 41.5.2.

41.6 Vertical wall

41.6.1 A heater shall not cause ignition (see 41.6.3) of the terry cloth material or the plywood when the heater is operated at a distance from the wall that results in the highest temperatures on the plywood wall. See 41.6.2 – 41.6.7.

Exception: A wall-mounted heater that is marked as described in 59.23, and ceiling surface-mounted or recessed ceiling heaters are exempted from this test.

41.6.2 With respect to 41.6.1, the highest temperatures are usually encountered at the closest distance a heater can be placed to the wall, except that:

a) A limit control may operate and not permit operation of the heater for sufficient length of time to produce the highest temperatures. In this case additional tests are to be conducted at increased distances between the heater and the wall. The test time at each distance is to be sufficient to observe the ultimate results. See 41.6.4.

b) If a radiant type heater is provided with a reflector, the reflector may have a focusing effect that causes higher temperatures at a greater distance than the minimum distance between the heater

and the wall. In this case additional tests are to be conducted at increased distances. The test time at each distance is to be sufficient to observe the ultimate results. See 41.6.4.

41.6.3 With respect to 41.6.1, manifestation of ignition of terry cloth or plywood is glowing, emission of embers, or flaming. Charring without glowing or without emission of embers is not ignition.

41.6.4 With respect to 41.6.2, to observe the ultimate results, the test is to be continued for 7 hours. However, the test may be discontinued after 2 hours if this duration of testing produces no discoloration of the terry cloth material.

41.6.5 A cord-connected heater not marked as described in 59.23 is to be supported on a horizontal surface that abuts the vertical wall. The side of the heater that radiates or convects heat is to face the wall. The wall is to consist of 3/4-inch (19.1-mm) thick fir plywood, and is to be covered with one layer of terry cloth material. The wall is to extend at least 12 inches (305 mm) beyond the heater on both sides and 12 inches above the heater. Any heater projections such as guards or grilles in the front of the heater that do not require tools for their removal (see 10.7) are to be removed.

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

Exception: For a heater that may be used at an elevated location and that:

a) Includes a stand or feet that project beyond other heater surfaces in front of the heater and

b) Is provided with air outlet openings lower than 4-1/4 inches from the floor, the height of the "toe space" is to be adjusted to a minimum height permitted by the stand or feet.

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

Exception: A heater that may be used at an elevated location that includes a stand or feet that extend beyond the front of the heater shall be tested using a wall that includes a "toe space" as described in 41.6.6 and also using a wall without a "toe space".

41.7 Terry cloth drape

41.7.1 A heater, loosely covered with a single layer of terry cloth, shall not cause the cloth to glow or flame.

Exception: A wall-mounted heater that is marked as described in 59.23, and ceiling surface-mounted or recessed ceiling heaters are exempted from this test.

41.7.2 A heater provided with a temperature limiting control that does not operate due to partial draping of the heater shall also be subject to the terry cloth drape test, Section 41.7, under such partial draping conditions.

41.7.3 To determine if an air heater complies with the requirement in 41.7.1, it is to be operated until constant temperatures are attained and then covered with a single layer of terry cloth. The test is to be repeated (if acceptable results are obtained for the initial condition) beginning with the heater at room

temperature 25 ±3°C (77 ±5°F). The tests under the two conditions may be combined by initially draping the heater, and after equilibrium conditions are obtained, replacing the terry cloth with a new single layer.

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

41.7.4 A wall-insert heater is to be mounted in accordance with 38.4 with the terry cloth supported from points on the front wall surface approximately 1 foot (305 mm) above the top edge of the heater. See 37.4.

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

41.7.6 In a test to determine whether a combination heater and motor-driven fan complies with the requirement in 41.7.1, the fan is to be operating when the heater is covered with terry cloth.

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

41.8 Litter

41.8.1 A heater of the radiant type designed for permanent, horizontal, outdoor mounting and having a flat top surface or comparable cover is to be tested to determine the heating effect upon combustible material that might accumulate on it. For this purpose, dry, shredded newspaper is to be placed on the upper surface or cover in such quantity as would be representative of litter, birds' nests, and the like.

41.8.2 A floor-insert heater is to be horizontally mounted in the intended manner and operated in a wall angle as described in 38.1. An adjustable shutter, if provided as a part of the heater, is to be set at the position that will result in maximum temperatures being attained during the test. When temperatures have become stabilized, the register is to be covered for 25, 50, 75, and 100 percent of its area, respectively, with a terrycloth-covered wooden frame. The frame is to consist of three layers of terrycloth (see 39.1) stretched taut over one face of frame of 1- by 2-inch (25- by 51-mm) wood, having a shape and size somewhat greater than the register. The frame is to be so placed that the terrycloth is in direct contact with the register.

41.9 Motor overload and stalled motor

41.9.1 Motors protected by a remote protective device

41.9.1.1 A motor protected by a remote protective device in accordance with 21.1(b) shall not burn out nor shall there be other evidence of risk of fire when tested in accordance with 41.9.1.2 – 41.9.1.6.

41.9.1.2 The motor and its protective device are to be connected in the intended manner to a supply circuit having a voltage in accordance with 36.10. Temperatures are to be measured by thermocouples secured to the surface of the motor coils.

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

Exception No. 1: A motor that encounters an ambient higher than normal room ambient, 25 – 26°C (77 – 79°F), during the applicable normal temperature test may be tested in a lower ambient. However, the maximum allowable temperatures specified in 41.9.1.4 and 41.9.1.5 are to be reduced by the difference between the ambient encountered in intended operation and the test ambient.

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

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

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

41.9.1.5 When the rotor of a motor is locked, the winding temperature for a Class A insulated motor shall not exceed 200°C (392°F) during the first hour of operation and 175°C (347°F) thereafter. After the first hour of operation, the average temperature [that is, the average of:

a) The arithmetic mean of the maximum temperatures and

b) The arithmetic mean of the minimum temperatures] shall not exceed 150°C (302°F).

For a Class B insulated motor, the corresponding temperatures shall not exceed 225°C (437°F) for the first hour, 200°C after the first hour, and 175°C for the average temperature.

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

41.9.2 Impedance-protected motors

41.9.2.1 An impedance-protected motor shall comply with the applicable requirements in the Standard for Overheating Protection for Motors, UL 2111, under the conditions to which the motor is exposed in the heater, with the rotor locked. Compliance with this requirement is to be determined in accordance with 41.9.2.2 for permanently installed heaters and cord-connected heaters that are intended to be operated in a specific fixed position, such as cord-connected wall-mounted heater, and 41.9.2.3 for cord-connected portable heaters. See 41.9.2.4.

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

41.9.2.2 A permanently connected heater or a cord-connected heater intended to be operated in a specific fixed position is to be installed and operated in accordance with Sections 36 – 38, with the rotor of the motor locked.

41.9.2.3 A cord-connected, floor-supported heater is to be arranged as specified in Condition for Operation Tests, Section 37. The heater and the motor are to be energized in accordance with 36.8 and 36.10. The heater is to be operated with the rotor of the motor locked with the heater located in a test alcove described in 38.1 under the conditions described in 38.14.

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

41.10 Wall-mounted heaters

41.10.1 Padded surface

41.10.1.1 A wall-mounted heater, when tested in accordance with 41.10.1.2 – 41.10.2.1, shall not cause the cheesecloth, felt, blanket material, or wood to glow or flame.

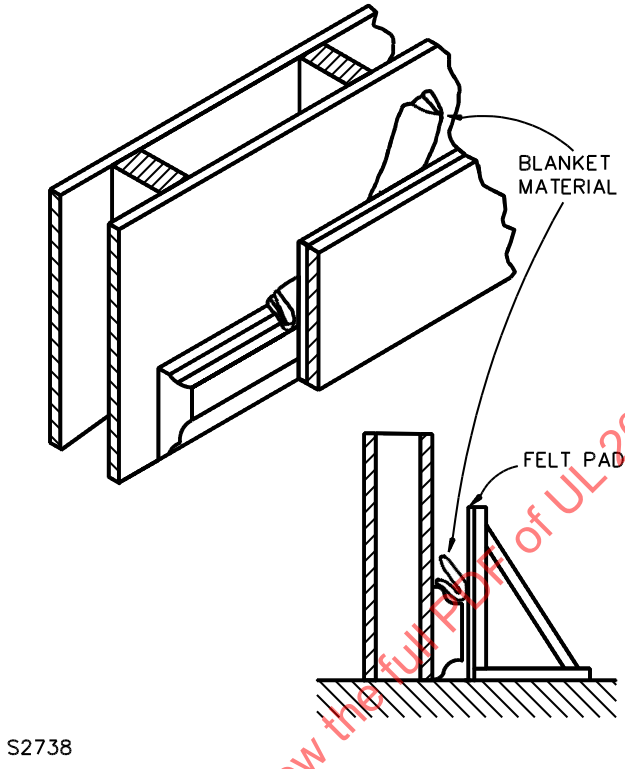
Exception: A wall mounted heater that is marked as described in 59.23 is exempted from these tests.

41.10.1.2 A wood surface covered with a 1-inch (25.4-mm) thick felt pad, and with the pad, in turn, covered by a double layer of cheesecloth, is to be supported in a vertical position as near the heater as the construction of the latter will permit. The heater is to be covered to such an extent as to produce maximum heating of the cheesecloth, and the padded surface is to extend at least 3 inches (76 mm) above the top surface of the heater. During the test, the covered wood surface is to be moved horizontally 1/2 inch (13 mm) away from its initial position and operation is to be continued until temperatures stabilize. If it is determined that its temperature increases when the surface is moved horizontally, the test is to be repeated with the surface in the new position starting with the heater at approximately room ambient temperature. The wood surface is to be rigid of sufficiently construction so that it will not change shape (bow or warp) during the test.

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

Figure 41.1

Test of wall-mounted heater



41.10.2 Curtain drape

41.10.2.1 A heater shall not cause a curtain draped in front of it to glow or flame.

41.10.2.2 The upper edge of a simulated curtain at least 3 feet (0.9 m) high, but long enough to be supported at least 1 foot (300 mm) above the heater in any case, is to be continuously attached to the wall at the base of which the heater is installed. The curtain is to consist of white duck as specified in 41.7.4 and an overlay of a double layer of cheesecloth on the side facing the heater, and is to be hung so that the lower edge just touches the floor. During the test, the entire length of the heater is to be initially covered and the curtain is to be arranged to conform as closely as possible with the contour of the heater. Those sections judged to be least likely to affect the operation of the limit control are to be covered. This test shall then be repeated with first:

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

b) 1/2 of the heater covered, and then with

c) 1/4 of the heater covered.

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

41.11 Floor insert heaters

41.11.1 Newspaper test

41.11.1.1 A floor insert heater is to be operated as described in 36.8, 37.1, 38.1, and 38.4. Two sheets of newspaper having face dimensions equal to the grill of the heater are to be shredded into strips and the

strips are then to be slowly (over a period of 5 minutes) inserted through the heater's grill. There shall be no glowing or flaming of the dry, shredded paper while the heater is operated for 7 hours or until the ultimate results have been observed.

41.11.2 Water splash test

41.11.2.1 A cotton mop, which was completely immersed in a pail of water for at least 5 minutes, is to be immediately upon removal from the pail swabbed across the floor insert heater's grill five times with the heater initially energized. Immediately following a last swabbing operation, the insulation resistance measurement and dielectric voltage-withstand tests and to be performed. There shall be no dielectric breakdown as a result of this test and the insulation resistance shall be at least 50,000 ohms.

41.12 Ceiling-panel heaters

41.12.1 A ceiling-panel heater shall not become a risk of fire when subjected to:

a) Physical abuse, as might occur from improper handling during installation, or

b) Water leakage after installation.

41.12.2 The details of a test procedure to simulate the effects of physical abuse cannot be specified completely because of the various types of implements that may be used and the various conditions that may exist during the installation of a ceiling-panel system. However, the following may be considered as examples of appropriate test procedures, although these may be modified and supplemented if deemed necessary. Sample panels are to be placed on a floor surface with the upper surface of the panel (the side that would be hidden after the panel is installed) exposed. One sample is to be subjected to three successive impacts from a 10-inch (254-mm) screwdriver dropped at random from a height of 6 feet (1.83 m). Another sample is to be subjected to the impact of a hammer having a mass of 3 pounds (1.361 kg) dropped in the same manner. If the panel is so constructed that it might sustain hidden damage if dropped while being installed, a sample is to be dropped to the floor from a height of 6 feet (1.8 m). After the impacts and drops, the tested samples are to be mounted in a ceiling section in the intended manner and then energized. Line fuses of the current rating that would be employed with the panel are to be installed in the power-supply leads, and any metal parts of the panel enclosure or adjacent metal associated with the mounting are to be solidly grounded. While energized, the samples are to be observed for evidence of adverse damage such as hot spots, arcing, glowing, or other unacceptable conditions.

41.12.3 To simulate the effect of condensation or of water leaking through a ceiling onto a panel-heater installation, several samples of the panels are to be supported in a horizontal position and energized as intended. Fuses of the current rating that would be employed with the panels are to be installed in the power-supply leads. Metal parts of the panel enclosure and adjacent metal supporting surfaces that would be grounded are to be connected solidly to ground. A quantity of water necessary to thoroughly saturate the test samples is then to be poured over the exposed upper surfaces of the samples. The samples are to be energized, and to be observed for arcing, glowing, or other adverse conditions. Blowing of the line fuse is not considered to be unacceptable unless accompanied by arcing, glowing, or other manifestation of a risk of fire in the panel itself.

41.13 Abnormal ambient test

41.13.1 General

41.13.1.1 A heater that employs a temperature limit control in accordance with Exception (a) to 24.1 shall be subjected to an abnormal ambient test in accordance with either Condition 1 or Condition 2 as specified in 13.2.1 and 13.3.1, respectively. The test is to be continued for 7 hours with the heater operated at the maximum rated input. There shall be no manifestation of fire during the test or occurrence of damage to the heater to the extent that after the test the heater does not comply with the requirements

for Enclosure, Section 7. Subsequent to this test, the heater shall comply with the Normal Temperature Test, Section 36.

Exception No. 1: The abnormal ambient test need not be conducted for a heater in which the average "on" time per cycle over four cycles of operation on the limit control during each abnormal operation temperature test does not exceed 5 percent and the average "on" time does not exceed 1 minute. The limit control used shall withstand an endurance test consisting of 100,000 cycles of operation making and breaking its rated load (see Endurance Test, Section 42).

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

a) The heater completes the full 7 hour terry cloth band drape test,

b) During the full terry cloth band drape test temperatures are measured as noted in the Normal Temperature Test, Section 36, and

c) The temperatures measured during the normal temperature test are equal to or greater than the temperatures obtained during the terry cloth band drape test with the product operating on the limit control.

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

a) Complies with the stalled fan test (see 41.3.1 – 41.3.5) and temperatures are measured as noted in the Normal Temperature Test, Section 36, and

b) If the steady state temperatures measured during the normal temperature test are equal to or greater than the temperatures obtained during the locked rotor test with the product operating on the limit control. The overshoot temperatures are not to be considered if they last for less than 5 minutes.

41.13.2 Condition 1

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

41.13.3 Condition 2

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

42 Endurance Test

42.1 An automatic control and an automatic-control assembly (that is, a thermostat and related contactor) shall withstand an endurance test consisting of the number of cycles indicated in Table 42.1. Unless it is specified that the test be made without load, the current-rupturing device shall make and break the rated current of the heater while connected to a circuit of voltage specified in 36.8. There shall be no electrical or mechanical malfunction of the automatic control or associated contactor or undue burning, pitting, or welding of contacts.

42.2 With reference to 42.1 and Table 42.1, thermostats are classified as follows:

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

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

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

Table 42.1
Number of cycles of operation for endurance test

Type of Thermostat	Automatically Reset Thermostat	Manually Reset Thermostat
Temperature-regulating	A number of cycles equivalent to 1000 hours of intended operation of the heater, or 30,000 if a commercial heater. However, the test may be omitted if, with the thermostat short-circuited, no temperatures higher than the rises given in Table 36.1 are attained during the normal-temperature test of the heater.	To be made the subject of special consideration. No value is specified because of unlikely occurrence.
Temperature-limiting	A number of cycles equivalent to 100 hours of operation of the heater under any condition which causes thermostat to function, or 100,000 cycles, whichever is greater. However, the test may be omitted if, with the thermostat short-circuited, there is no evidence of a risk fire as described in 41.1.1 – 41.2.1 during the continuous abnormal operation of the heater[a].	1000 cycles under load 5000 cycles without load. However, the test may be omitted if, with the thermostat short-circuited, there is no evidence of a risk of fire as described in 41.1.1 – 41.2.1 during continuous abnormal operation of the heater.
Combination temperature-regulating and -limiting	100,000 if, with the thermostat short-circuited, there is evidence of a risk of fire as described in 41.1.1 – 41.2.1. If there is no evidence of a risk of fire under this condition, the thermostat is to be tested as a temperature-regulating thermostat (see above)[a].	To be made the subject of special consideration. No value is specified because of unlikely occurrence.

[a] Complete test is required – no part omitted.

43 Short-Circuit Tests

43.1 Devices and conductors referenced in 23.1.3.6 shall withstand short circuit and ground fault conditions when protected by:

a) A device that is acceptable for branch circuit protection and is located in the heater, or

b) A branch circuit overcurrent protective device of the type and maximum rating specified on the heater nameplate. There shall be no damage to the conductor or its termination, no ignition of the cheesecloth surrounding the enclosure housing the components under test, and no arc-over between line- and low-voltage circuits.

43.2 For the purpose of these tests:

a) Circuit breakers and fuses are not considered to be interchangeable,

b) Fuses of the same rating are considered to be interchangeable,

c) HACR type circuit breakers of the same rating are considered to be interchangeable, and

d) Circuit breakers of other than the HACR type are not considered to be interchangeable with each other or with HACR type circuit breakers.

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

Table 43.1
Short-circuit test currents

Product ratings, amperes				Circuit capacity amperes
Single phase				
110 – 120 V	200 – 208 V	220 – 240 V	254 – 277 V	
9.8 or less	5.4 or less	4.9 or less	–	200
9.9 – 16.0	5.5 – 8.8	5.0 – 8.0	6.65 or less	1000
16.1 – 34.0	8.9 – 18.6	8.1 – 17.0	–	2000
34.1 – 80.0	18.7 – 44.0	17.1 – 40.0	–	3500
Over 80.0	Over 44.0	Over 40.0	Over 6.65	5000
3 Phase				Circuit capacity amperes
200 – 208 V	220 – 240 V	440 – 480 V	550 – 600 V	
2.12 or less	2.0 or less	–	–	200
2.13 – 3.7	2.1 – 3.5	1.8 or less	1.4 or less	1000
3.8 – 9.5	3.6 – 9.0	–	–	2000
9.6 – 23.3	9.1 – 22.0	–	–	3500
Over 23.3	Over 22.0	Over 1.8	Over 1.4	5000

43.4 Three samples of each conductor are to be subjected to each test condition. A new protective device is to be used for each test condition. Consideration is to be given to both short-circuit and ground-fault conditions.

44 Overload Test – High-Voltage Transformers

44.1 This test applies to a high-voltage transformer provided with thermal protection of other than the nonrenewable thermal cutoff type. See 23.1.2.1.

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

44.3 A variable resistance load is to be connected to the output terminals and the transformer is to be operated continuously at the normal test voltage indicated in 36.8. If the protective device controls a switching device that, in turn, interrupts primary current to the transformer, the switching device is to be included in the circuit. The test ambient temperature is to be approximately 25°C (77°F). The resistance load is to be adjusted so that the transformer winding is brought to a stabilized temperature of approximately 10°C (18°F) below its insulation rating. The load is then to be gradually increased until operation of the protector occurs.

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

44.5 Upon completion of this test, each sample shall comply with the Dielectric Voltage-Withstand Test, Section 46.

45 Burnout Test – High-Voltage Transformers

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

Exception: This test does not apply to a high-voltage transformer that is provided with thermal overload protection of other than the nonrenewable thermal cutoff type (see 23.1.2.1) or that is protected by an overcurrent device or devices complying with the requirements in 23.1.3.1 – 23.1.3.6.

45.2 Three samples of the transformer are to be operated continuously at the normal test voltage indicated in 36.8 and at rated frequency with the enclosure grounded. The test ambient temperature is to be approximately 25°C (77°F) and operation is to be continued until constant temperature is indicated by a thermocouple on the enclosure or until burnout occurs. The circuit on which the transformer is tested is to be protected by fuses rated not less than that required for the heater.

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

a) A resistance load to provide a current equal to three times the full rated transformer secondary current, or

b) If the transformer supplies a motor with or without additional loads, a resistance load to provide a current equal to the motor locked rotor current plus any additional loads, or

c) If the transformer supplies an inductive load (other than a motor), such as the coils of relays, solenoids, and the like, a resistance load to provide a current equal to the sum of such loads with the armature of the largest blocked open.

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

46 Dielectric Voltage-Withstand Test

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

46.2 To determine whether or not a heater complies with the requirement in 46.1, it is to be tested by means of a 500-volt-ampere or larger capacity transformer, the output voltage of which can be regulated and is essentially sinusoidal. The increase in the applied potential is to be at a uniform rate and as rapidly as consistent with its value being correctly indicated by a voltmeter.

47 Insulation Resistance Test

47.1 A heater employing thermal insulation such as mineral wool in contact with uninsulated live parts or electrical insulating material that is likely to be affected adversely by moisture under the conditions of intended use shall have an insulation resistance of not less than 50,000 ohms after exposure for 24 hours to moist air having a relative humidity of 85 ±5 percent at a temperature of 32.0 ±2.0°C (89.6 ±3.6°F). See 17.2.

47.2 Ordinarily, insulation resistance is to be measured by a voltmeter having an internal resistance of at least 30,000 ohms and using a 250-volt direct-current circuit.

48 Rain Test

48.1 When tested as described in 48.2 – 48.5, an air heater intended for outdoor use shall:

a) Have an insulation resistance of not less than 50,000 ohms between live parts and interconnected noncurrent-carrying metal parts;

b) Withstand without breakdown for 1 minute the application of a 60-hertz essentially sinusoidal potential between live parts and interconnected noncurrent-carrying metal parts. The test potential (rms) shall be 1000 volts if the heater is rated 250 volts or less, and shall be 1000 volts plus twice rated voltage if it is rated more than 250 volts; and

c) A heater intended for permanent connection to the supply circuit by means of wiring enclosed in conduit shall have no evidence of water in the portion of the heater enclosure in which the splice connection to the branch-circuit wiring is located.

48.2 During the test, the heater is to be mounted or supported as it would be in actual service. If a drive-in-theater heater provided with a shelter, shield, or the like (see 59.34), is to be mounted therein. A radiant reflector-type heater is to be suspended in any intended operating position.

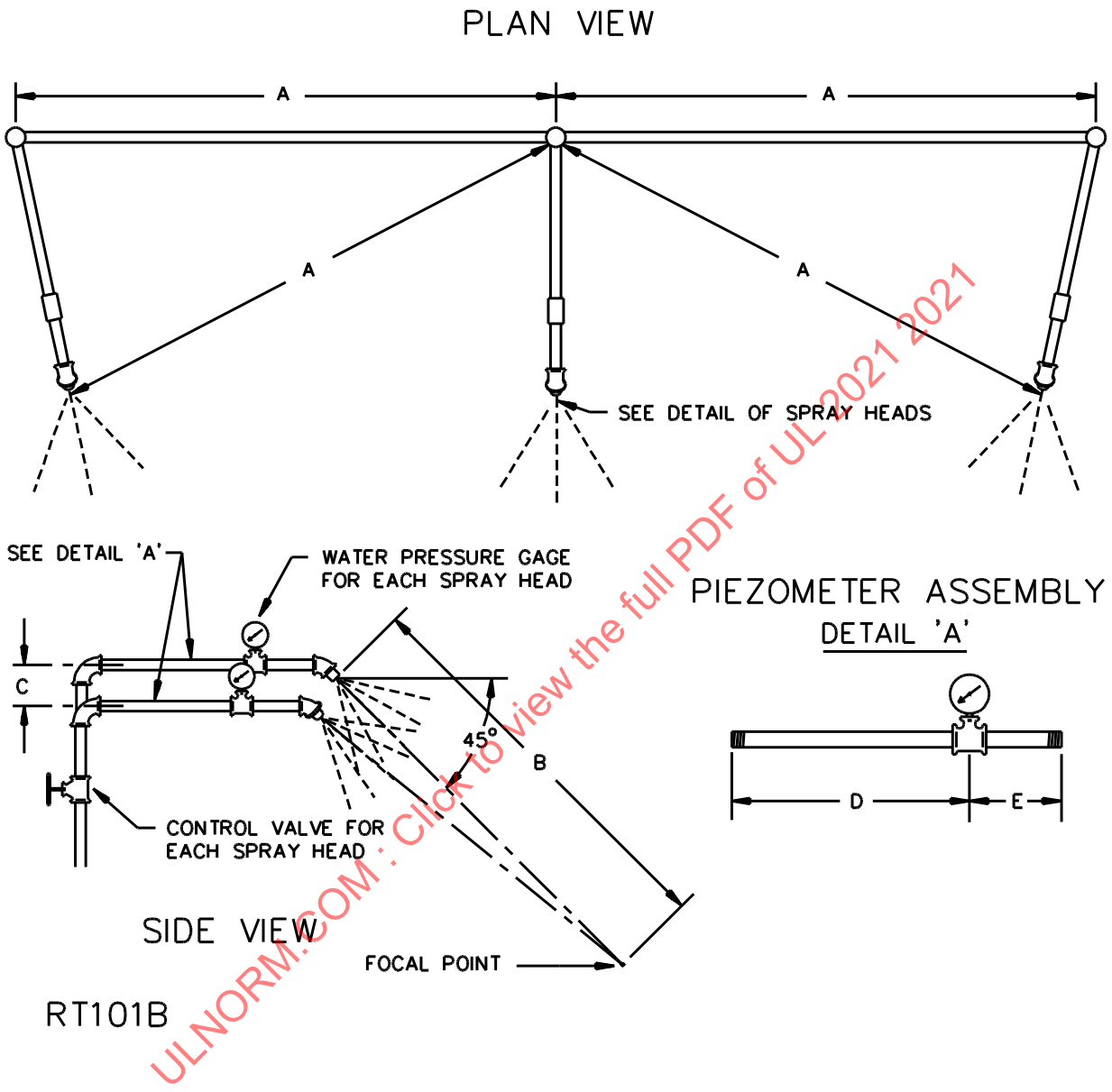
48.3 The heater is to be subjected for 4 hours to a water spray as described in 48.5 applied at an angle of 45 degrees from the vertical. The insulation-resistance and dielectric voltage-withstand tests are to be conducted immediately upon conclusion of exposure to the water spray.

48.4 At the conclusion of the tests, a heater as mentioned in 48.1(c) is to be dried thoroughly on the outside and then disassembled and examined for the presence of water in the splice compartment.

48.5 The water-spray-test apparatus is to consist of three spray heads mounted in a water supply pipe rack as illustrated in Figure 48.1. Spray heads are to be constructed in accordance with the details illustrated in Figure 48.2. The heater is to be positioned in focal area of the spray heads so that the greatest quantity of water is likely to enter the heater. The water pressure is to be maintained at 5 pounds per square inch (34.5 kPa) at each spray head.

Figure 48.1

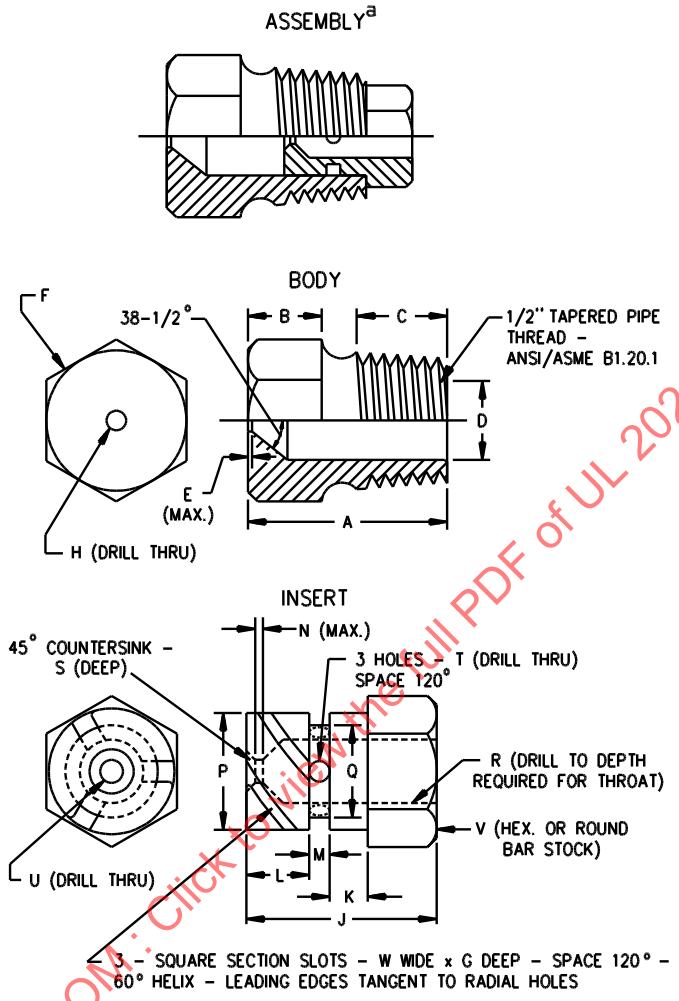
Rain-test spray-head piping



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

Figure 48.2

Spray head



RT100C

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

[a] Nylon Rain-Test Spray Heads are available from Underwriters Laboratories Inc.

[b] ANSI B94.11M Drill Size

[c] Optional – To serve as wrench grip.

49 Static Load Test

49.1 The register of a floor-insert heater shall withstand a static load of 300 pounds force applied to a surface area of 1 square foot (14.4 kPa) at the center of the register without any permanent deflection and without distortion of the register support.

50 Stability of Cord-Connected, Floor-Supported Heaters

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

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

51 Element Support Impact Tests

51.1 A cord-connected, freestanding heater shall neither emit sparks, flames, or molten metal, nor cause the terry cloth to ignite, nor open a 1/2 ampere fuse of other than the time-delay type installed in accordance with 51.2, when tested as described in 51.5 – 51.7.

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

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

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

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

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

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

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

51.7 The sample in the as-received condition is to rest on the hardwood surface covered with two layers of terry cloth. While energized at the rated voltage, the sample is to be tipped over five times in the manner specified in 51.8. The first tipover is to be onto the front face of the heater and then subsequent tipovers are to proceed in the clockwise or counterclockwise direction, one tipover onto face or side, with the last tipover again onto its front face. If the angel of critical balance (see 28.19) exceeds 60 degrees, the heater is not to be tipped over in this direction, but a total of five tipovers are to be made with each sample tested.

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

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

51.10 With reference to 51.2, a dead metal part is to be considered accessible if it does not comply with the accessibility requirements for uninsulated live metal parts in 7.20 and 7.26, and if the dead metal part can become energized by direct or indirect contact with a broken heating element.

52 Test for Permanence of Cord Tag

52.1 General

52.1.1 To determine compliance with 59.26, representative samples that have been subjected to the tests described in 52.2.2 – 52.3.1 shall comply with the following requirements:

a) The tag shall resist tearing for longer than 1/16 inch (1.6 mm) at any point;

b) The tag shall not separate from the power supply cord;

c) There shall be no permanent shrinkage, deformation, cracking, or any other condition that will render the marking on the tag illegible; and

d) Overlamination shall remain in place and not be torn or otherwise damaged. The printing shall remain legible.

52.2 Test conditions

52.2.1 For each type of conditioning mentioned in 52.2.2 – 52.2.4, three samples of the tag applied to the power supply cord in the intended manner are to be used. If tags are applied by an adhesive, tests are to be conducted no sooner than 24 hours after application of the tag.

52.2.2 Three samples are to be tested as received.

52.2.3 Three samples are to be tested at the end of 30 minutes of conditioning at a room temperature of 23 ±2°C (73.4 ±3.6°F) and 50 ±5 percent relative humidity, following conditioning in an air-circulating oven at 60 ±1°C (140 ±1.8°F) for 240 hours.

52.2.4 Three samples are to be tested within 1 minute after exposure for 72 hours to a relative humidity of 85 ±5 percent at 32 ±2°C (89.6 ±3.6°F).

52.3 Test method

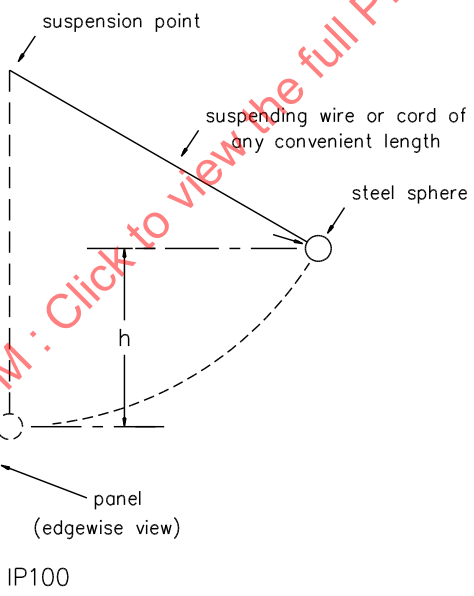
52.3.1 Each sample is to consist of a length of power supply cord to which the tag has been applied. The power supply cord, with the attachment plug pointing up, is to be held tautly in a vertical plane. A force of 3 pounds (13.3 N) is to be applied for 1 minute to the upper most corner of the tag farthest from the power supply cord, within 1/4 inch (6.4 mm) of the vertical edge of the tag. The force is to be applied vertically downward in a direction parallel to the major axis of the cord. In determining compliance with 52.1 (d), manipulation is permissible, such as straightening of the tag by hand. To determine compliance with 52.1 (e), each sample is to be scraped ten times across printed areas and edges, with a force of approximately 2 pounds (8.9 N), using the edge of a 5/64 inch (2.0 mm) thick steel blade held at a right angle to the test surface.

53 Protection Against Personal Injury Test

53.1 Unless it is intended for mounting in a location (such as a ceiling) where it is not likely to be exposed to physical abuse, a panel of glass or similarly brittle material employed in a heater shall withstand, without cracking or breaking, the impact resulting from the test described in Figure 53.1.

Figure 53.1

Impact test



NOTES –

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

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

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

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