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