UL 1261

STANDARD FOR SAFETY

Electric Water Heaters for Pools and Tubs

UL Standard for Safety for Electric Water Heaters for Pools and Tubs, UL 1261

Sixth Edition, Dated September 2, 2016

Summary of Topics

This revision of ANSI/UL 1261 is being issued to clarify button or coin cell batteries of lithium technologies requirements.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated July 14, 2017.

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.

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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

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INTRODUCTION

1 Scope

1.1 These requirements cover permanently installed electric water heaters, rated 600 volts or less, for heating the water supplied through plumbing to separately heated public or private pools or tubs, in which swimming, wading, bathing, or partial or total immersion of persons, may be involved. Equipment covered may or may not be intended for use with external water circulating equipment, and is intended for installation in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements do not cover household storage tank water heaters or other equipment covered by individual requirements.

2 Glossary

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

2.2 ACTUATION – Movement of the actuating member of the control by the user, by hand, by foot, or by any other human activity.

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

2.4 CONTROL, LIMITING – A control intended to limit the operation of the heater to a water temperature of 70°C (158°F) under all conditions, including breakdown of any or all operating controls.

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

2.6 CONTROL, OPERATING – A device that starts or regulates the operation of an appliance during normal operation. The failure of an operational control generally causes the operation of a protective control. An example of an operating control is a temperature regulating control – a control that maintains the temperature of the spa water to a user-determined level.

2.7 CONTROL, PROTECTIVE – A device, the operation of which is intended to reduce the risk of electric shock, fire, or injury to persons during normal or abnormal operation of the appliance. During the evaluation of the protective control / circuit, the protective functions are verified under normal and single-fault conditions of the control.

2.8 CONTROL, TYPE 2 ACTION – The actuation of an automatic control (see 2.3) for which the manufacturing deviation and the drift of its operating value, operating time, or operating sequence have been declared and tested under the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

2.9 CONTROL, TYPE 2.D.H ACTION – This action is applicable to manual controls (see 2.5). The automatic action (i.e. tripping of the control) is independent of the manipulation or position of the manual reset/adjustment mechanism. The manipulation of the manual adjustment means will not allow for the reverse operation (resetting of a ″tripped″ control), even momentarily, while the excess or fault condition persists. This action is also referred to as trip-free action. The action of the control is such that the reverse operation (resetting) is possible if the manual reset mechanism is held in the reset position – i.e. the control will function as an automatic control if the reset button is held in the reset position. The control shall not reset automatically at any temperature above -35°C (-31°F) with the reset mechanism in the normal position.

2.10 CONTROL, TYPE 2.D.J ACTION – This action is applicable to manual controls (see 2.5). The automatic action (i.e. tripping of the control) is independent of the manipulation or position of the manual reset/adjustment mechanism. The manipulation of the manual adjustment means will not allow for the reverse operation (resetting of the control), even momentarily, while the excess or fault condition persists. This action is also referred to as trip-free action.

2.11 CONTROLLED ENVIRONMENT – An environment that is relatively free from conductive contaminants, such as dust and carbon particles, and that is protected against humidity and condensation. A controlled environment may be provided by a hermetically sealed enclosure, encapsulation, or a conformal coating.

2.12 HOT TUB – A tub intended for partial or total immersion of persons in heated water.

2.13 LOW-VOLTAGE CIRCUITS – A low-voltage circuit is one involving a potential of not more than 30 volts rms (42.4 volts peak) supplied by a primary battery, by a standard Class 2 transformer, or by a combination of a transformer and a fixed impedance that, as a unit, complies with all of the performance requirements for a Class 2 transformer. A circuit derived from a source of supply at line voltage by connecting resistance in series with the supply as a means of limiting the voltage and current is not considered to be a low-voltage circuit.

2.14 OPERATING TEMPERATURE VALUE – Value of temperature at which the temperature sensing control operates on a rise or fall of the temperature.

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

2.16 TEMPERATURE SETTING BY THE USER – Any selection of an operating temperature value by actuation performed by the user.

3 Safety Critical Functions

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

3.2 Electronic circuits that manage a Safety Critical Function shall be:

a) Reliable as defined as being able to maintain the Safety Critical Function in the event of single defined component faults and

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

3.3 Electronic circuits managing Safety Critical Functions shall comply with:

a) Supplement SA; or

b) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and its Part 2s as specified in this standard. The function shall be considered Class B; or

c) The Standard for Temperature-Indicating and -Regulating Equipment, UL 873, and the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, requirements specified in Supplement SB.

3.4 Functions specified in Table 3.1 represent the common safety critical circuit functions of units. It is not intended to represent all possible Safety Critical Functions.

Table 3.1
Safety Critical Functions

Function (see 3.1)	Hazard	Location of parameters and tests
Temperature regulating control	Scalding	Section 19
Temperature limiting control	Scalding	Section 20

CONSTRUCTION

4 Component Specifications

4.1 General

4.1.1 Except as indicated in 4.1.2, a component of a product covered by this standard shall comply with the requirements for that component as indicated in this Section.

4.1.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard,

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.

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

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

4.1.5 Components shall be suitable for the intended use and installation environment. This suitability shall assume the following installation parameters.

a) Outdoor, Pollution Degree III installations.

b) Overvoltage Category II as specified in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840.

4.1.6 Components not anticipated by the requirements of this Standard, not specifically covered by a component standard of Component Specifications, Section 4, and which pose a potential risk of electric shock, fire or casualty hazard shall be additionally investigated. Reference to other product standards is appropriate where those standards anticipate normal and abnormal use conditions consistent with the application of this Standard

4.2 Quick-connect wire connectors

4.2.1 Quick-connect type wire connectors shall be suitable for the wire size, type (solid or stranded), conductor material (copper or aluminum) and the number of conductors terminated. If insulated, they shall be rated for the voltage and temperature of the intended use. They shall be applied per the installation instructions of the wire connector manufacturer.

4.2.2 Quick-connect type wire connectors shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310.

4.3 Terminal blocks

4.3.1 Terminal blocks shall comply with:

a) The Standard for Terminal Blocks, UL 1059, or

b) The Standard for Low-Voltage Switchgear and Controlgear – Part 7-1: Ancillary Equipment – Terminal Blocks for Copper Conductors, UL 60947-7-1, or

c) The Standard for Low-Voltage Switchgear and Controlgear – Part 7-2: Ancillary Equipment – Protective Conductor Terminal Blocks for Copper Conductors, UL 60947-7-2, or

d) The Standard for Low-Voltage Switchgear and Controlgear – Part 7-3: Ancillary Equipment – Safety Requirements for Fuse Terminal Blocks, UL 60947-7-3.

4.3.2 The UL 60947-7-x Standards are used in conjunction with the Standard for Low-Voltage Switchgear and Controlgear – Part 1: General Rules, UL 60947-1.

4.3.3 Terminal blocks shall be suitable for the number of conductors per termination, wire size, type (solid or stranded), conductor material (copper or aluminum), voltage and current of the intended use.

4.4 Wire connectors

4.4.1 Wire connectors shall be suitable for the wire size, type (solid or stranded), conductor material (copper or aluminum) and the number of conductors terminated. If insulated they shall be suitable for the voltage and current of the intended use. They shall be applied per the installation instructions of the wire connector manufacturer.

4.4.2 Wire connectors shall comply with the Standard for Wire Connectors, UL 486A-486B, or the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

4.5 Boxes and raceways

4.5.1 Electrical boxes and the associated bushings and fittings, and raceways, of the types specified in Chapter 3, Wiring Methods and Materials, of the National Electrical Code, ANSI/NFPA 70, and that comply with the relevant UL standard (such as the Standard for Metallic Outlet Boxes, UL 514A, the Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C, the Standard for Cover Plates for Flush-Mounted Wiring Devices, UL 514D) are considered to comply with the requirements of this end product standard.

4.6 Overcurrent protection

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

4.6.2 Fuseholders shall comply with the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1, and the applicable Part 2 (e.g. UL 4248-9).

4.6.3 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 the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

4.6.4 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.

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

4.7 Switches

4.7.1 Switches shall comply with one of the following, as applicable:

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

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

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

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

4.7.2 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.

4.7.3 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 6,000 cycles of operation, or as a manual control for 5,000 cycles of operation, in accordance with 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.

4.7.4 Switches that comply with the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1, shall be rated as specified in 4.7.5 – 4.7.7.

4.7.5 Power switches shall be rated as follows:

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

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

c) For Continuous Duty;

d) With respect to load:

1) Switches for motor-operated appliances: for resistance and motor load in accordance with the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1, or Outline for Particular Requirements for Switches for Tools, UL 6059, if the switch would encounter this load in normal use; or

2) Switches may be regarded as switches for a declared specific load in accordance with the UL 61058-1, or UL 6059, and may be classified based upon the load conditions encountered in the appliance under normal load.

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

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

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

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

a) Power switches: 6000 cycles;

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

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

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

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

2) Switches for 20 mA load as classified in the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1.

4.8 Relays and contactors

4.8.1 Relays shall be suitable for the voltage, current and type of load controlled and shall comply with the Standard for Industrial Control Equipment, UL 508.

4.9 Transformers

4.9.1 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.

4.9.2 Class 2 and Class 3 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 3: Class 2 and Class 3 Transformers, UL 5085-3.

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

4.10 Printed wiring boards

4.10.1 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 the Standard for Printed-Wiring Boards, 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.

4.10.2 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 the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

4.10.3 Unless otherwise specified, the flammability class and temperature rating shall be that specified for insulating materials in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

4.11 Temperature sensing thermistor devices

4.11.1 A temperature sensing device, such as a positive temperature coefficient (PTC) thermistor and a negative temperature coefficient (NTC) thermistor, that is used in combination with an electronic control and that together with the control provides an operating or protective function shall comply with the Standard for Thermistor-Type Devices, UL 1434.

4.11.2 The thermistors described in 4.11.1 shall be investigated for:

a) Endurance Test: 100,000 cycles (all types),

b) Temperature Excursions: Outdoor Use Conditions

4.11.3 The calibration tolerance allotted to the thermistor, plus the calibration tolerance allotted to the electronic control, shall not exceed the required as-received (Deviation) system tolerance of ±5°F (±3°C); and the required after conditioning (Drift) system tolerance of ±10°F (±6°C).

4.12 Button or coin cell batteries of lithium technologies

4.12.1 *Revised and relocated as 5.7.*

5 Frame and Enclosure

5.1 General

5.1.1 The frame and enclosure of a heater shall have the strength and rigidity required to resist the abuses to which it will encounter during normal service, thus precluding total or partial collapse of the enclosure with the attendant reduction of spacings, loosening or displacement of parts, and other defects that alone or in combination constitute an increase in the risk of fire, electric shock, or injury to persons.

5.1.2 Among the factors to be determined when an enclosure is evaluated for acceptability are its:

a) Physical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Combustibility;

e) Resistance to corrosion; and

f) Resistance to distortion at temperatures likely to be encountered under normal or abnormal conditions of use.

For a nonmetallic enclosure, these factors are to be determined with due regard for deterioration due to aging or other foreseeable environmental exposures.

5.1.3 Besides the factors listed in 5.1.2, an enclosure of sheet metal shall be evaluated with regard to its size, shape, the thickness of the metal, and its intended application.

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5.2 Protection of combustible materials outside the enclosure

5.2.1 The enclosure shall reduce the risk of molten metal, burning insulation, flaming particles, or the like from falling on combustible materials, including the surface upon which the heater is supported.

5.2.2 The requirement in 5.2.1 requires use of a barrier of combustion resistant material under wiring, unless it is of the flame-retardant type. Neoprene-, asbestos-, or thermoplastic-insulated wires are considered to be of this type.

5.2.3 A switch, transformer, relay, solenoid, or the like shall be individually enclosed unless it can be shown that breakdown of the component will not result in a risk of fire, or unless there are no openings in the bottom of the overall heater enclosure. An unbaffled opening located directly below field- or factory-made splices or overcurrent-protective devices in the bottom of such a heater enclosure is not to be used.

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

5.3 Ventilating openings

5.3.1 An opening in the enclosure for ventilation, 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 reduce the risk of emission of flame, molten metal, burning insulation, or the like from the heater.

Exception: In a compartment other than one that houses an overload or overcurrent protective device, the baffles are not prohibited from being omitted when:

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

b) The heater is constructed so that baffles are not required, as shown by investigation.

5.3.2 When an opening is provided in the enclosure of a heater or in an externally mounted component intended for permanent connection to the power supply, it shall be located so that it will not vent into concealed spaces of a building structure, such as into hollow spaces in the walls or the like, when the equipment is installed as intended.

Exception: The requirement in this paragraph does not apply to an opening for a mounting screw or nail or for a manufacturing operation such as a paint drainage hole, when such an opening has a dimension not greater than 17/64 inch (6.7 mm), or an area of more than 0.055 square inches (35.5 mm^2).

5.4 Thickness of enclosure materials

5.4.1 Cast- and sheet-metal portions of an enclosure shall not be thinner than indicated in Table 5.1 unless the enclosure is determined to be acceptable when evaluated under considerations such as those specified in 5.1.2 and 5.1.3.

Table 5.1
Minimum thickness of enclosure metal

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

[a] Thinner sheet metal is not prohibited from being used when the enclosure is evaluated under considerations such as those specified in 5.1.2 and 5.1.3.

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

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

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

c) 0.045 inch (1.14 mm) if nonferrous.

5.4.3 An enclosure shall have a thickness not less than the following at points where the face of an attachment plug receptacle projects through it:

a) 0.032 inch (0.81 mm) if the enclosure is of ferrous material;

b) 0.045 inch (1.14 mm) if the enclosure is of nonferrous material; and

c) 0.10 inch (2.5 mm) if the enclosure is of insulating material. The insulating material shall be combustion resistant.

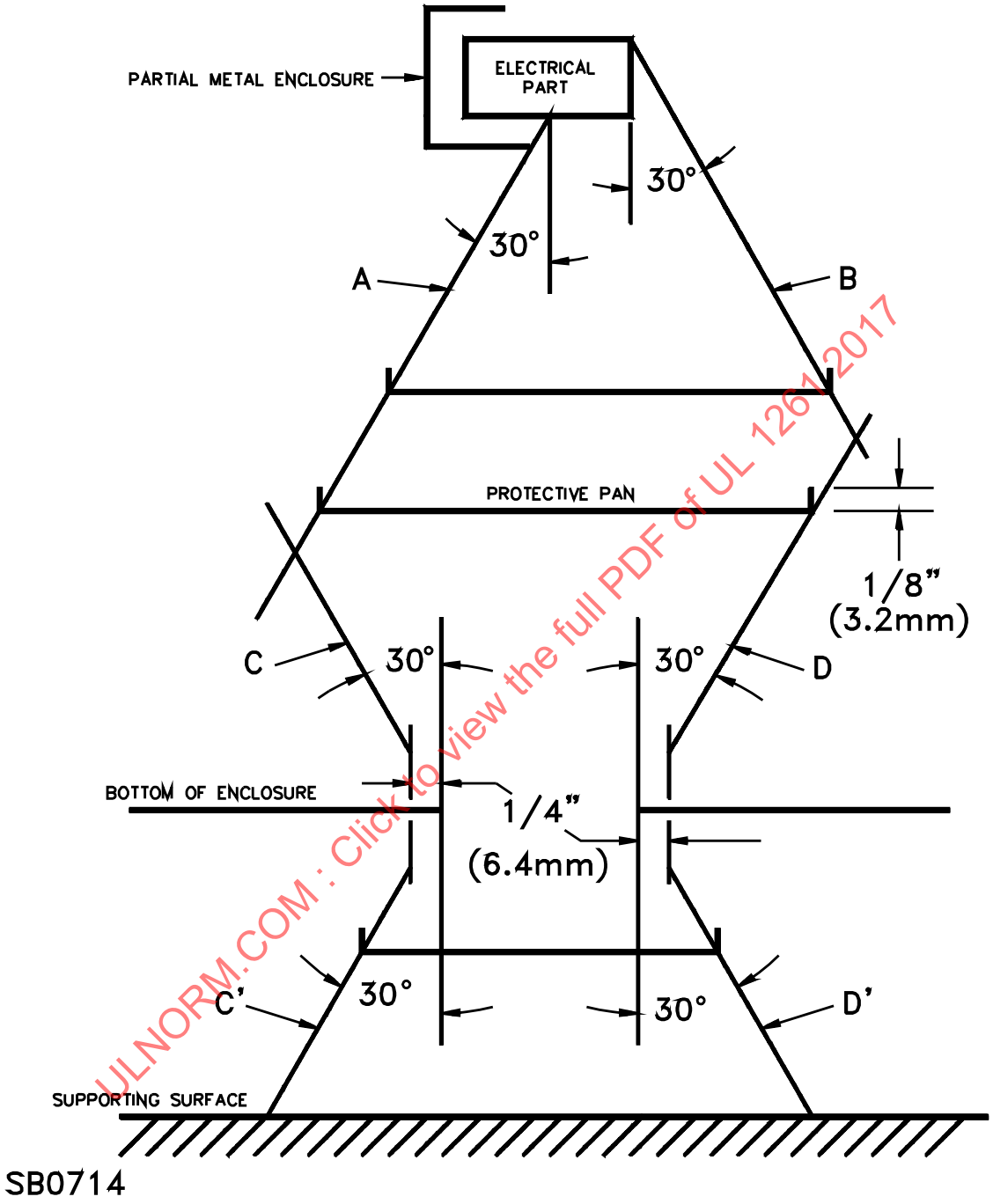
Exception: An enclosure of insulating material is not prohibited from being of lesser thickness when it is formed or reinforced so that it provides equivalent physical strength.

5.5 Openings

5.5.1 An opening in the bottom of an appliance shall not be located below an electrical part unless a solid, noncombustible pan complying with Figure 5.1 is interposed between the electrical part and supporting surface. The pan is to have a rim, lip, or other raised edge that is in a horizontal plane and extends all the way around the pan. The bottom of the pan need not be flat or any regular shape and the transition from the bottom to the rim, lip, or the like may have any convenient shape, but at every point directly below the electrical part, the floor of the pan is to be 1/8 inch (3.2 mm) or more below the plane of the rim, lip, or the like.

5.5.2 The structure of the part or of the appliance may provide the equivalent of the pan described in 5.5.1 when it complies with Figure 5.1. The raised edge may be incorporated in the opening.

Figure 5.1
Minimum extent of baffle for opening in bottom of enclosure



A, B, C, and D are projections that define a volume between an electrical part and an opening; C' and D' are projections that define a volume between an opening and the supporting surface. A protective pan in any horizontal plane between the part and the opening in the supporting surface must be larger than the area defined by projections A, B, C, and D, or projections C' and D', respectively. Three examples of protective pans are illustrated in the figure, two are above the opening and one is below it.

5.6 Accessibility of uninsulated live parts

5.6.1 To reduce the risk of unintentional contact that may involve a risk of electric shock from an uninsulated live part or injury to a person, an opening in an enclosure shall comply with (a) or (b).

a) For an opening that has a minor dimension (see 5.6.3) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 5.2. If the minor dimension is less than 3/4 inch (19.1 mm), the articulate probe without the web stop may be used.

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 5.2.

Figure 5.2
Articulate probe with web stop

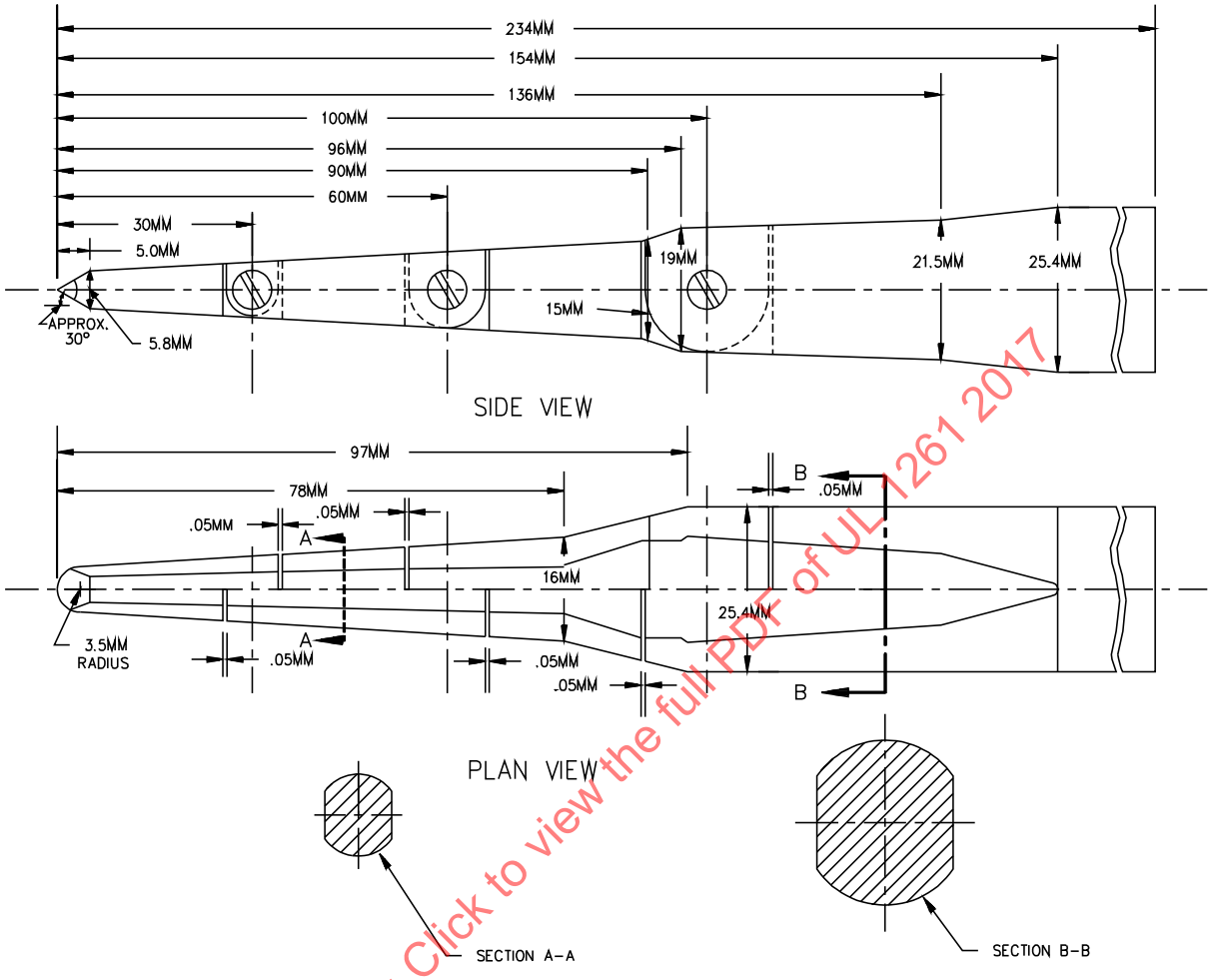


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Table 5.2
Minimum distance from an opening to a part that may involve a risk of electric shock or injury to persons

Minor dimension of opening[a], inches[b]	(mm)[b]	Minimum distance from opening to part, inches[b]	(mm)[b]
1	(25.4)	6-1/2	(165)
1-1/4	(31.8)	7-1/2	(190)
1-1/2	(38.1)	12-1/2	(318)
1-7/8	(47.6)	15-1/2	(394)
2-1/8	(54.0)	17-1/2	(444)
c		30	(762)

[a] See 5.6.4.
[b] Between 1 inch and 2-1/8 inches, interpolation is to be used to determine a value between values specified in the table.
[c] More than 2-1/8 inches, but not more than 6 inches (152 mm).

5.6.2 The probe specified in 5.6.1 and illustrated in Figure 5.2 shall be applied to any depth that the opening will permit and shall be rotated or angled before, during, and after insertion through the opening to any position that is required to examine the enclosure. The probe illustrated in Figure 5.2 shall be applied in any possible configuration and, if required, the configuration shall be changed after insertion through the opening.

5.6.3 The probe specified in 5.6.1 and 5.6.2 shall be used as a measuring instrument to evaluate the accessibility provided by an opening, and not as an instrument to evaluate the strength of a material. The probe shall be applied with the minimum force required to determine accessibility.

5.6.4 With reference to the requirements in 5.6.1, 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.

5.6.5 During the examination of equipment in connection with the requirements in this section, a part of the outer enclosure that may be removed without the use of a tool 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 removed. Such a part shall not be assumed to provide protection against electric shock or personal injury.

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

5.6.7 The door or cover of an enclosure shall be hinged if it gives access to any fuse, circuit breaker, or manually-resettable limiting control in other than a low-voltage circuit, and if any uninsulated live part is exposed during the normal replacement of the fuse. Such a door or cover shall also be provided with an automatic latch or the equivalent and, if any live part other than the screw shell of a plug fuseholder is exposed inside the enclosure, a captive screw (or similar means requiring the use of a tool to open) shall be provided to secure the door or cover in place, and the cover shall be legibly and permanently marked in accordance with 40.1.6.

5.6.8 A protective device shall be wholly inaccessible from outside the heater without opening a door or cover; however, the operating handle of a circuit breaker, the operating button of a manually-resettable limiting control, or a similar part may project outside the enclosure.

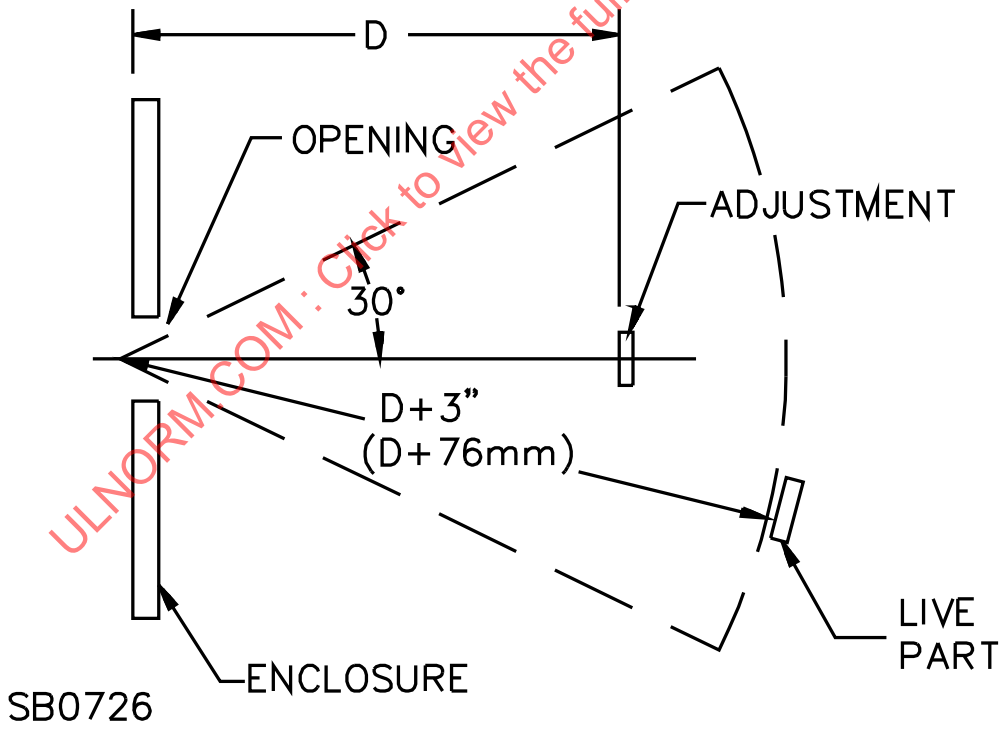
5.6.9 A door or cover giving access to any overload protective device in other than a low-voltage circuit shall be tight-fitting and shall overlap the surface of the enclosure around the opening.

5.6.10 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 is determined to be an acceptable means for holding the door in place as required in 5.6.6.

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

5.6.12 If an opening is provided to gain access to a control that is intended to be reset, adjusted, or otherwise manipulated by the user or service personnel, it shall not be possible to contact a live uninsulated or enamel insulated part with a 1/16 inch (1.6 mm) diameter rod applied as described in 5.6.13 and as illustrated in Figure 5.3.

Figure 5.3
Accessibility of live part through adjustment opening



5.6.13 With reference to the requirement in 5.6.12, the rod is to be inserted through the opening to its maximum depth and positioned in all possible directions without producing an angle of more than 30 degrees between the rod and a line connecting the center of the opening with the center of the face of the adjusting mechanism. The length of the rod beyond the opening is not to exceed the distance between the opening and the face of the adjusting mechanism by more than 3 inches (76 mm).

5.7 Button or coin cell batteries of lithium technologies

5.7.1 The battery compartment of an appliance or any accessory, such as a wireless control, incorporating one or more coin cell batteries of lithium technologies shall comply with the Standard for Products Incorporating Button or Coin Cell Batteries of Lithium Technologies, UL 4200A, if the appliance or any accessory:

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

b) The appliance is intended for household use.

6 Metal in Contact With Water

6.1 A metal tank and associated metal pipe fittings that are in contact with pool water shall be of:

a) Copper, copper alloy, or stainless steel, any of which is at least 0.036 inch (0.91 mm) thick. If a copper alloy has a zinc content, such content shall not exceed 15 percent;

b) Cast iron at least 1/4 inch (6.4 mm) thick;

c) Steel at least 0.067 inch (1.7 mm) thick, if the surface of the steel in contact with water is galvanized or glass lined. The zinc coating shall be a minimum of 0.0017 inches (0.043 mm) thick as determined by the method specified in 34.1, and the minimum average thickness of the glass lining shall be 0.005 inches (0.13 mm). The minimum average thickness of the glass lining is to be calculated from six thickness measurements, all taken at different locations. Each measurement is to be made by first measuring the thickness of the metal with the glass lining, then subtracting the measured thickness of the metal after breaking off the glass; or

d) Aluminum or aluminum alloy at least 0.093 inch (2.36 mm) thick if the surface in contact with water is glass lined. The minimum average thickness of the glass lining shall be 0.005 inches (0.13 mm) as measured by the method described in (c).

As an alternative to the specifications in 6.1 (a) – (d), a tank that bears the symbol of the Boiler and Pressure Vessel Code, ANSI/ASME BPVC, consisting of the Code H, S, M, U, UM, or HLW in a clover leaf may be used.

6.2 Any pipe or fitting of iron or steel in contact with water shall be protected against corrosion by galvanizing or plating. Zinc coating used for corrosion protection shall be a minimum 0.0017 inches (0.043 mm) thick as determined by the method specified in 34.1.

7 Field-Wiring Connections

7.1 General

7.1.1 A heater shall have provision for connection of a wiring system.

7.1.2 If the heater includes a length of flexible conduit for the heater supply leads, the flexible conduit shall be steel and an outlet box, control box, or similar enclosure intended for connection to the supply wiring system shall be provided on the end of the flexible conduit. Unless the conduit is terminated in an outlet box or other enclosure not larger than 2 by 4 by 4 inches (51 by 102 by 102 mm) for splice connections, locknuts on the fittings are not considered to be an acceptable means of preventing the loosening of the conduit fittings. An equipment grounding conductor sized in accordance with 10.3 shall be included unless:

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 not larger than 3/4-inch trade size unless the fittings are identified as providing grounding.

7.1.3 A knockout for connection of a field wiring system to a field wiring compartment shall accommodate conduit of the trade size shown in Table 7.1.

Table 7.1
Trade size of conduit in inches

Wire size,		Number of wires				
AWG	(mm^2)	2	3	4	5	6
14	(2.1)	1/2	1/2	1/2	1/2	1/2
12	(3.3)	1/2	1/2	1/2	3/4	3/4
10	(5.3)	1/2	1/2	1/2	3/4	3/4
8	(8.4)	3/4	3/4	3/4	1	1
6	(13.3)	3/4	1	1	1-1/4	1-1/4
4	(21.2)	1	1	1-1/4	1-1/4	1-1/2
3	(26.7)	1	1-1/4	1-1/4	1-1/2	1-1/2
2	(33.6)	1	1-1/4	1-1/4	1-1/2	2
1	(42.4)	1-1/4	1-1/4	1-1/2	2	2
1/0	(53.5)	1-1/4	1-1/2	2	2	2-1/2

NOTE – This table is based on the assumption that all conductors will be of the same size and there will be not more than six conductors in the conduit. If more than six conductors will be involved or if all of them are not of the same size, the internal cross-sectional area of the smallest conduit that may be used is determined by multiplying by 2.5 the total cross-sectional area of the wires, based on the cross-sectional area of Type THW wire.

7.1.4 A wiring space or other compartment in a heater intended to be wired in the field that will enclose wires shall be free of any sharp edges, burrs, fins, moving parts, or the like that can damage the conductor insulation.

7.1.5 An opening in an enclosure for the entrance of a conductor shall be provided with a bushing of insulating material. The bushing shall be mounted in place in the opening or may be provided with the enclosure so that it may be mounted when the equipment is installed.

7.1.6 A bushing of rubber or rubber-like material provided in accordance with 7.1.5 shall not be less than 1/8 inch (3.2 mm) thick. A hole in which such a bushing is mounted shall be free of sharp edges, burrs, projections, or the like, that might damage the bushing.

Exception: When the metal around a bushing hole is eyeletted or otherwise treated to provide smooth edges, the bushing shall not be less than 3/64 inch (1.2 mm) thick.

7.2 Leads and terminals

7.2.1 A lead intended to be connected to the source of supply shall be rated for minimum 60°C (140°F) if the heater is rated at 80 amperes or less, and minimum 75°C (167°F) if the heater is rated more than 80 amperes, even if such wiring material temperature rating would not be required for reasons of temperature alone.

7.2.2 A heater rated 80 amperes or less shall be provided with field-wiring terminals or leads for the connection of conductors having an ampacity not less than 125 percent of the current rating of the heater and sized on the basis of 60°C rated conductor ampacities. A heater rated more than 80 amperes shall tbe provided with field-wiring terminals or leads for the connection of conductors having an ampacity not less than 125 percent of the current rating of the heater and sized on the basis of 75°C rated conductor ampacities.

7.2.3 A field-wiring terminal of a heater that is marked as being intended for either copper or aluminum conductors as indicated in 40.3.1, shall be of a size that can accommodate the conductor sizes specified in 7.2.2, considering such factors as heating, heat cycling, and the like.

7.2.4 A lead for connection of field wiring shall not be more than two standard (AWG) sizes smaller than the branch circuit power supply or control circuit conductor (copper) to which it will be connected, and shall not be smaller than a 14 AWG (2.1 mm^2) copper conductor in any case.

7.2.5 In determining the size of the power supply conductors in equipment intended for connection to multiple power supplies and in which more than six such conductors will be likely to occupy the same raceway, the additional ampacity deratings shall be applied.

7.2.6 A terminal for field connection of a control circuit conductor may be used if it is intended for the connection of a 14 AWG (2.1 mm^2) copper conductor. A copper lead for field connection of a control circuit conductor may be 16 or 18 AWG (1.3 or 0.82 mm^2).

Exception: A terminal in a low-voltage circuit may be used, if it is sized for connection of a 16 AWG or 18 AWG copper conductor.

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

Exception: A wire-binding screw may be used at a field-wiring terminal intended to accommodate a 10 AWG (5.3 mm^2) or smaller conductor.

7.2.8 Where continuity or secureness of an electrical connection involves a threaded joint, at least two full threads shall be engaged in the threaded joint and, for a screw with a tapered end, any threads on the tapered end shall be disregarded.

Exception: The threaded joint of a component complying with applicable component requirements for threaded joint design, continuity, and secureness is not required to comply with this requirement.

7.2.9 Where pigtail leads are provided for field-wiring connections, a threaded joint at the product end of the lead shall comply with 7.2.8.

7.2.10 A field-wiring terminal shall be prevented from turning or shifting in position by means other than friction alone. Acceptable means of complying with this requirement include use of two screws or rivets, square shoulders or mortises, dowel pins, lugs, offsets, or connecting straps or clips fitted into an adjacent part, or by an equivalent method.

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

Exception No. 1: A No. 8 (4.2 mm) screw may be used for the connection of a 14 AWG (2.1 mm^2) conductor.

Exception No. 2: A No. 6 (3.5 mm) screw may be used for the connection of a 16 AWG (1.3 mm^2) control conductor.

7.2.12 A 14 AWG (2.1 mm^2) conductor is the smallest conductor that may be anticipated at a terminal for the connection of a power supply wire.

7.2.13 A terminal plate tapped for a wire-binding screw shall be of metal at least 0.050 inch (1.3 mm) thick.

Exception: A plate not less than 0.030 inch (0.8 mm) thick is not prohibited from being used when the tapped threads have strength equivalent to those in a terminal plate at least 0.050 inch thick.

7.2.14 Upturned lugs or a cupped washer or the equivalent shall be provided with a wire-binding screw and shall be capable of retaining a conductor that corresponds to the rating of the heater, but not smaller than 14 AWG (2.1 mm^2), under the head of the screw or washer.

7.2.15 A wire-binding screw shall thread into metal.

7.2.16 A heater rated 125 or 125/250 volts (three-wire) or less shall have one terminal or lead identified for the connection of the grounded conductor of the power supply circuit. No switch, overcurrent protective device, or limit control of the single pole type shall be connected in the grounded conductor.

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

7.2.18 The free length of a lead inside an outlet box or wiring compartment shall be at least 6 inches (152 mm) if the lead is intended for field connection to an external circuit.

8 Field Wiring Compartments

8.1 A heater shall be provided with a compartment for supply wiring connections. The volume of the compartment shall be at least that indicated in Table 8.1. When determining total compartment volume from the table, a conductor running through the compartment and each conductor originating outside the compartment and terminating inside the compartment is to be counted as one conductor.

Table 8.1
Minimum volume of field wiring compartments

Size of conductor, AWG	Size of conductor, (mm^2)	Free space in compartment for each conductor, cubic inches	Free space in compartment for each conductor, (cm^3)
14	(2.1)	2.0	(33.0)
12	(3.3)	2.25	(36.9)
10	(5.3)	2.5	(41.0)
8	(8.4)	3.0	(49.2)
6	(13.3)	5.0	(82.0)

8.2 The depth of the compartment in the vicinity of any opening at which supply conductors may enter shall be such that the required space for wire bending and manipulation will remain between any wire connector, wiring lug, conduit knockout, or conduit hole and any wall of the wiring compartment that would result in the wire bending, as specified in Table 8.2.

Table 8.2
Wire bending space

Size of wire, AWG or MCM	Size of wire, (mm^2)	Minimum bending space from connector, lug, knockout, or hole to wall			
		Wire per pole			
		1		2[a]	
		inch	(mm)	inch	(mm)
14 – 10 AWG	(2.1 – 5.3)	Not specified	Not specified	–	–
8 – 6 AWG	(8.4 – 13.3)	1-1/2	(38.1)	–	–
4 – 3 AWG	(21.2 – 26.7)	2	(50.8)	–	–
2 AWG	(33.6)	2-1/2	(63.5)	–	–
1 AWG	(42.4)	3	(76.2)	–	–
1/0 – 2/0 AWG	(53.5 – 67.4)	3-1/2	(88.9)	5	(127)
3/0 – 4/0 AWG	(85.0 – 107.2)	4	(102.0)	6	(152)
250 MCM	(127)	4-1/2	(114.0)	6	(152)

[a] Applies when two conductors can approach the terminal only from the same direction.

8.3 An opening provided in the wiring compartment for the connection of conduit in the field shall be in accordance with Table 7.1, and the minimum trade size of conduit required for use with the smallest conductor capable of carrying the load current. When making this determination, aluminum conductor wires shall be assumed unless the unit is marked for copper supply wiring only.

8.4 The location of a terminal box or compartment intended for the connection of power supply wiring shall be such that the box or compartment is accessible for inspection of the supply wire connections after the heater is installed. Moving the installed heater for such inspection shall not be required.

8.5 With reference to 8.4, it is to be assumed that accessibility for inspection exists if, after the heater is installed in the intended operating position, the connections can be examined without using any special tool (such as an offset screwdriver, and the like) or disturbing the wiring in the compartment.

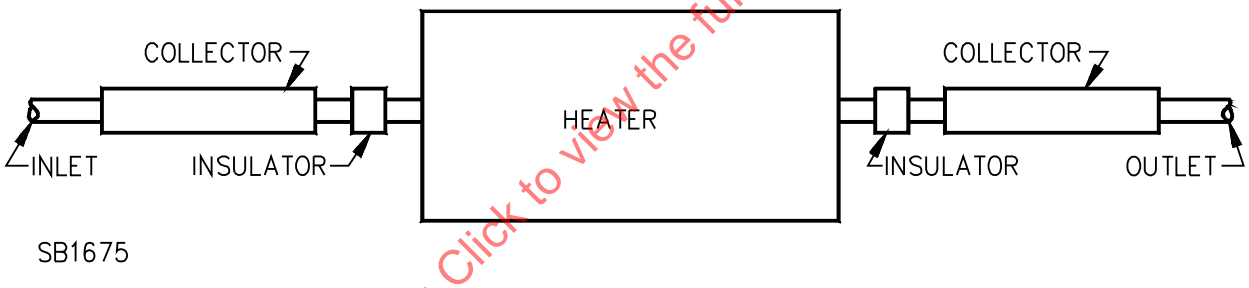
8.6 A supply wiring terminal compartment shall be attached to the heater and prevented from turning in relation to it.

9 Leakage Current Collectors

9.1 A leakage current collector shall be provided at the water inlet, and another at the outlet of the heater, and these shall be electrically insulated from the heater. The installation of the collectors shall be such that all water entering and leaving the heater flows through the two collectors as shown in Figure 9.1.

Exception: This requirement does not apply to a construction determined to be acceptable as the result of the leakage current test described in Leakage Current in Water, Section 36.

Figure 9.1
Leakage current collector diagram



9.2 A leakage current collector shall be of galvanized or other corrosion resistant metal pipe, and shall be a minimum length of five times its own inside diameter. Each leakage current collector shall have provision for the connection of a grounding conductor not smaller in cross section than the heater power supply conductors.

9.3 A leakage current collector shall be permanently factory installed on the heater, or provided with the heater together with field installation instructions as described in 42.9.

10 Equipment Grounding

10.1 A field-wiring terminal or lead for the connection of an equipment grounding conductor shall be provided.

10.2 A field-wiring terminal intended solely for connection of an equipment grounding conductor shall be a screw-type connector capable of securing a conductor of a size as described in 10.3 and shall comply with the requirements in 7.2.1 – 7.2.16.

10.3 An equipment grounding conductor shall be at least the same size as the power supply conductors, and in no case shall it be smaller than 12 AWG (3.3 mm^2).

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

10.5 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 colored.

Exception: The requirements in 10.5 that cover the color coding of grounding leads apply to internal wiring that is visible in a wiring compartment in the area in which field connections are to be made. They do not apply to leads or wiring of low-voltage circuits intended to be field connected to Class 2 wiring and that are separated or segregated from high-voltage circuit, field-wiring connections by barriers.

11 Bonding For Grounding

11.1 An exposed dead-metal part and a dead-metal part inside the enclosure that is exposed to contact during any servicing operation, maintenance, or repair, and that is likely to become energized, shall be electrically connected to the equipment grounding terminal or lead and to the metal surrounding the knockout, hole, or bushing provided for field connection to the power supply.

11.2 An uninsulated dead-metal part of a cabinet, electrical enclosure, mounting bracket, controller mounting assembly, capacitor, or other electrical component shall be bonded for grounding purposes.

Exception: A metal part as described in (a) – (d) is not required to be bonded.

a) Adhesive-attached, metal-foil markings; screws; handles; and the like located on an enclosure or cabinet and isolated from electrical components or wiring by grounded metal parts so that they are unlikely to become energized.

b) Isolated metal parts such as contactor magnet frames or armatures, small assembly screws, and the like that are positively separated from wiring and other uninsulated live parts.

c) Panels and covers that do not enclose uninsulated live parts if wiring is positively separated from the panel or cover so that ii is not likely to become energized.

d) Panels and covers that are insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic material, or similar material not less than 1/32 inch (0.8 mm) thick that is secured in place.

11.3 A heater shall have, on the external surface or inside the box, panel, or wiring compartment where the equipment grounding conductors are to be connected, a wire connector able to accommodate a 8 AWG (8.4 mm^2) solid copper wire for the purpose of bonding the grounded metal to pool steel or other local common bonding grid in the area of the swimming pool heater. If this connector is inside the box panel or wiring compartment, a knockout shall be provided for the passage of a 8 AWG wire.

11.4 All wire connectors provided for bonding to the pool bonding grid, or for bonding leakage current collectors to the heater, shall be stainless steel, brass, copper, or copper alloy.

12 Live or Current-Carrying Parts

12.1 General

12.1.1 An electrical part of a heater shall be located or enclosed so that protection against unintentional contact with any live part will be provided.

12.2 Current-carrying parts

12.2.1 Plated iron or steel may be used only for current-carrying parts having normal operating temperatures of more than 100°C (212°F), but unplated iron or steel shall not be used for any current-carrying part. Stainless steel and other such corrosion-resistant alloys may be used for current-carrying parts, regardless of temperature.

13 Enclosure of Live Parts and Wiring

13.1 A terminal or lead for field connections, a terminal of a component such as an element, thermostat, and the like, and internal wiring shall be enclosed within a metal housing or enclosure that complies with Frame and Enclosure, Section 5.

13.2 An enclosure that houses wires shall be smooth and entirely free from sharp edges, burrs, fins, moving parts, and the like that can damage wiring.

13.3 A live or current-carrying part shall be secured to the base or mounting surface so that it cannot turn or shift position if such motion could result in the reduction of electrical spacings below the minimum values specified in Electrical Spacings, Section 21.

14 Internal Wiring

14.1 General

14.1.1 For the purpose of these requirements, the internal wiring of a heater is determined to be all the interconnecting wiring beyond the wiring terminals or leads for field-wiring connections, even though some of the wires may not be completely enclosed, or may be in the form of flexible cord.

14.1.2 Internal wiring shall consist of wires of a size corresponding to the rating of the heater, and in no case smaller than 18 AWG (0.82 mm^2). The wiring shall be standard building wire, fixture wire, or other acceptable type, taking into consideration temperatures, voltage, and other conditions of service likely to be encountered.

14.1.3 There is no temperature limit applicable to a conductor provided with beads of noncarbonizable material. The number and arrangement of the beads shall be such as to maintain spacings as required in Electrical Spacings, Section 21. A conductor using beads shall not be used outside an enclosure or where it is accessible to inadvertent contact from outside the enclosure.

14.1.4 Insulated wire used for internal wiring may be of the following types:

a) Building Wire – Types RH, RHH, RHW, T, TW, THWN, and MTW.

b) Fixture Wire – Types RFH-2, SF-2, SFF-2, FFH-2, TF, TFF, TFN, and TFFN.

c) Flexible Cords – HPN, HS, HSJ, HSJO, HSO, S, SJ, SJO, SJT, SJTO, SO, ST, STO, SP-2, SP-3, SPT-2, and SPT-3.

d) Appliance Wiring Material – Appliance wiring material shall have thermoplastic insulation not less than:

1) 1/32 inch (0.8 mm) thick for 18 – 10 AWG (0.82 – 5.3 mm^2);

2) 3/64 inch (1.2 mm) thick for 8 AWG (8.4 mm^2); and

3) 1/16 inch (1.6 mm) thick for 6 – 2 AWG (13.3 – 33.6 mm^2).

14.2 Wiring methods

14.2.1 The wiring and connections (if any) between external parts of a heater shall be protected or enclosed.

Exception: Flexible cord is not prohibited from being used for external connections or for internal connections that may be exposed during servicing, when flexibility of the wiring is essential.

14.2.2 Internal wiring that is exposed through an opening in the enclosure is determined to be protected as required by 14.2.1 when, upon evaluation as though it were enamel insulated, the wiring is determined to be in compliance with the requirements in Frame and Enclosure, Section 5. Such exposed internal wiring, even though it may be touched with a probe, may be used when it is protected or guarded so that it cannot be grasped or hooked in a manner that would subject the wire to stress.

14.2.3 When wiring is located so that it is in proximity to combustible material or capable of being subjected to abuse or damage, it shall be in metal-clad cable, rigid metal conduit, electrical metallic tubing, metal raceway, or the equivalent.

14.2.4 When wiring passing through a metal wall within the overall enclosure of a heater can contact the edge of the opening, the hole shall be provided with a smooth, turned edge, a metal grommet, or an insulating bushing.

14.2.5 A flexible cord used for external interconnection shall be provided with bushings and strain relief unless such a cord is otherwise protected against motion and stresses or strains that might be transmitted inside the unit.

14.2.6 When relative motion between asbestos-insulated wire and the metal surrounding the opening through which the wire passes is likely because of expansion and contraction of the metal, the opening shall be fitted with an insulating bushing or the equivalent.

14.3 Splices and connections

14.3.1 A splice or connection shall be made mechanically secure, and shall provide continuity of electrical contact.

14.3.2 A splice shall be provided with insulation equivalent to that on the spliced wires if permanence of spacing between the splice and uninsulated metal parts is not provided.

14.3.3 Where stranded wiring is connected to a wire-binding screw, loose strands of the wire shall be positively prevented from contacting any other uninsulated conductive part that is not always of the same electrical potential as the wire, or reducing electrical spacings to an unacceptable degree. This may be accomplished by using pressure terminal connectors, soldering lugs, or crimped eyelets, by soldering all strands of the wire together, or by equivalent means.

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

14.3.5 Wiring using wax-impregnated insulation shall not contact a control unit other than at the point of connection of the conductor to a terminal of the control. The wire shall leave the terminal in a downward direction, or a drip loop shall be provided adjacent to the point of connection to the terminal.

14.3.6 An aluminum conductor, insulated or not, used as internal wiring, such as for an interconnection between current-carrying parts, shall be terminated at each end by a method acceptable for the combination of metals involved at the connection.

14.3.7 If a wire-binding screw construction or a pressure wire connector is used as a terminating device for an aluminum conductor, it shall be acceptable for use with aluminum under the conditions involved, such as temperature, heat cycling, and the like.

15 Heating Elements

15.1 A heating element shall be securely supported in place.

15.2 In determining compliance with 15.1, consideration is to be given to sagging, loosening, and other adverse conditions of the element resulting from continuous heating or flexing of the element supports or related wiring due to alternate heating and cooling.

15.3 A sheathed heating element shall comply with the requirements in the Standard for Sheathed Heating Elements, UL 1030.

16 Electrical Insulation

16.1 An insulating washer, bushing, or other integral part of a heater or accessory, and a base or support for the mounting of a live part, shall be of a moisture-resistant insulating material that will not be adversely affected by the temperatures to which it will be subjected in service. A molded part shall be constructed so that it possesses the mechanical strength and rigidity to withstand the stresses of actual service.

16.2 An insulating material shall be evaluated with regard to its intended application. Materials such as mica, some molded compounds, and certain refractory materials are usually acceptable for use as the sole support of a live part. Some other materials such as magnesium oxide that are not acceptable for general use may be used only in conjunction with other insulating materials or when located and protected so that the risk of mechanical damage and absorption of moisture is reduced.

16.3 When it is required to investigate a material to determine acceptability, consideration shall be given to its mechanical strength, dielectric properties, insulation resistance, qualities of heat resistance, the degree to which it is enclosed or protected, and to any other features that may have a bearing on the performance of the material in actual service. All of these factors shall be determined with regard to thermal aging.

16.4 In the mounting or supporting of small, fragile insulating parts, screws or other fastenings shall not be so tight as to result in cracking or breaking of the part with expansion and contraction.

17 Thermal Insulation

17.1 Thermal insulation shall be of such material and located, mounted, and supported so that it will not be adversely affected by the conditions involved in normal operation of the heater.

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

17.3 Determination of the acceptability of an adhesive may be omitted if the thermal insulation is mechanically supported by at least one rivet or equivalent fastening per square foot (929 cm^2) of material.

18 Overcurrent Protection

18.1 General

18.1.1 A heater rated more than 48 amperes shall have the heating elements subdivided. Each subdivided circuit shall supply a set of heating elements having a total rating not exceeding 48 amperes, and each subdivided circuit shall be protected at not more than 60 amperes.

18.1.2 An overcurrent protective device provided to meet the requirement for maximum 48 ampere subdivided circuit protection shall be an integral part of the equipment.

18.1.3 The overcurrent protection required in 18.1.1 and 18.1.2 shall be of a type rated for branch circuit protection.

18.2 Receptacle, transformer, lampholder protection

18.2.1 Overcurrent protection at not more than 15 amperes shall be provided by a fuse or circuit breaker for each general use single receptacle unless the heater could be connected as intended to a branch circuit rated at 15 amperes or less.

18.2.2 Overcurrent protection at not more than 20 amperes shall be provided by a circuit breaker or fuse as a part of the equipment for each general use duplex receptacle circuit, transformer primary circuit, or lampholder circuit independent of a heating element unless the equipment could be connected as intended to a branch circuit rated at 20 amperes or less.

19 Temperature Regulating Controls

19.1 General

19.1.1 Each heating element shall be controlled by a thermostat so that the water at the heater outlet is maintained at a temperature of 50°C (122°F) or less.

19.1.2 A temperature regulating control may be adjustable, and may have marked or unmarked dial settings, but it shall not have any dial setting marked hotter than 50°C (122°F), and it shall be provided with a stop to prevent adjustment to a higher temperature setting.

19.2 Construction

19.2.1 A water temperature-regulating control shall have a tolerance at the maximum setting of not more than ±3°C (±5°F).

19.2.2 A water temperature-regulating control shall comply with either the requirements in a or b:

a) The water heater control requirements in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873. In addition, the control shall have a maximum tolerance of ± 3°C (± 5°F) and shall comply with the calibration verification and 100,000-cycle endurance requirements in UL 873. If part or all of the control is electronic, it shall comply with 19.1.1, 19.1.2.

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 Temperature Sensing Controls, UL 60730-2-9, with the parameters as specified in Table 19.1.

Table 19.1
Temperature-regulating control parameters

UL 60730-1, Table - Required information and methods of providing information	Information	Control requirement
6	Purpose of control	Protective control (temperature)
7	Type of load controlled	AC heater load
27	Number of Automatic cycles (A)	100,000
29	Type of disconnection or interruption	Micro-Disconnection
36	Limits of Activating Quantity	50°C (122°F)
39	Type 1 or Type 2 action	Type 2
40	Additional features	Automatic reset
41	Manufacturing Deviation, maximum	±3°C (±5°C)
42	Drift	Not vary from the as-received temperature by more than 5 percent of the Fahrenheit setpoint temperature, or by more than 10°F (6°C), whichever is the greater.
49	Pollution degree	Pollution degree 3
52	The minimum parameters of any heat dissipater (heat sink) not provided with an electronic control but essential to its correct operation	Must be specified

Table 19.1 Continued on Next Page

Table 19.1 Continued

UL 60730-1, Table - Required information and methods of providing information	Information	Control requirement
53	Output waveform if other than sinusoidal	Must be specified
58a	Required protection/immunity from mains	Required [a]
60	Surge immunity	IEC 61000-4-5 installation Class 3. Overvoltage category III.
74	External load and emission control measures to be used for test purposes	Intended heater

[a]For the purpose of the tests specified in Section "Electromagnetic compatibility (EMC) requirements – immunity" of UL 60730-1, the products covered by this Standard should be considered as:

a) Installation Class 3 (See Explanatory notes for surge immunity test, UL 60730-1);

b) Overvoltage Category III

c) Test Level 3

19.2.3 A relay or contactor controlled by the water temperature regulating control shall comply with the 100,000 cycle endurance test in the Standard for Industrial Control Equipment, UL 508.

19.2.4 A capillary tube or a sensing circuit for a water temperature-regulating or water temperature-limiting control water temperature control shall be provided with mechanical protection to reduce the risk of loss of water temperature control in the event of damage.

Exception: Mechanical protection is not required for a capillary tube or sensing circuit of a control that incorporates a construction that will open the heater circuit in the event of damage to the capillary tube or short or open circuit in the sensing circuit.

19.2.5 Mechanical protection is considered to be provided for a capillary tube or a sensing circuit for a water temperature control when it is contained entirely under the spa skirt and located so that it is not likely to be disturbed during user servicing

20 Temperature-Limiting Controls

20.1 A heater shall be provided with a temperature-limiting means that:

a) Prevents the water at the heater outlet from attaining a temperature hotter than 70°C (158°F);

b) Is trip-free in accordance with 20.2;

c) Is manually-resettable or is of the replaceable element type;

d) Is in addition to any temperature regulating control(s);

e) Opens all ungrounded power supply conductors;

f) Is readily accessible; and

g) Complies with the requirements for limiting controls.

20.2 With reference to 20.1(b), ″trip-free″ means that the device is constructed so that the contacts cannot be held in the closed position when the water has attained a temperature hotter than specified, regardless of the position of the actuating handle, button, lever, and the like.

20.3 With reference to 20.1(e), either a single-pole device or a multipole device may be used if there is one pole in each ungrounded power supply conductor. The requirement is applicable regardless of the number of power supply circuits used.

20.4 A temperature-limiting device shall have no operating parts in common with a temperature control thermostat; however, a common mounting bracket or enclosure is acceptable.

20.5 When the temperature-limiting device is in the control circuit of a magnetic contactor or relay, such a contactor or relay shall be wired so that it is not actuated by a temperature-regulating device.

20.6 Opening of either a grounded or ungrounded conductor of the supply circuit that renders a temperature-limiting control circuit inoperative shall also result in interruption of the current through the heating elements.

20.7 Such a control shall comply with the requirements in a, b, or c below.

a) The Standard for Limit Controls, UL 353.

b) The water heater limit control requirements in the Standard for Limit Controls, UL 353, or the water heater limiting control requirements in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873. Its reset mechanism shall be ″Manually Reset 2″ or ″M2″. If part or all of the control is electronic, it shall comply with 20.1 – 20.6.

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 Temperature Sensing Controls, UL 60730-2-9, with the parameters as specified in Table 20.1.

Table 20.1
Temperature-limiting control parameters

UL 60730-1, Table - Required information and methods of providing information	Information	Control requirement
6	Purpose of control	Manually Reset Thermal Cut-Out
7	Type of load controlled	AC heater load
27	Number of Automatic cycles (A)	6000: 1000 with load, 5000 without load
29	Type of disconnection or interruption	Full-Disconnection
36	Limits of Activating Quantity	70°C (158°F) setpoint
39	Type 1 or Type 2 action	Type 2
40	Additional features	Manual Reset, Type 2.D.J Action
41	Manufacturing Deviation, maximum	±3°C (±5°C)
42	Drift	Not vary from the as-received temperature by more than 5 percent of the Fahrenheit setpoint temperature, or by more than 10°F (6°C), whichever is the greater.
49	Pollution degree	Pollution degree 3

Table 20.1 Continued on Next Page

Table 20.1 Continued

UL 60730-1, Table - Required information and methods of providing information	Information	Control requirement
52	The minimum parameters of any heat dissipater (heat sink) not provided with an electronic control but essential to its correct operation	Must be specified
53	Output waveform if other than sinusoidal	Must be specified
58a	Required protection/immunity from mains	Required [a]
60	Surge immunity	IEC 61000-4-5 installation Class 3. Overvoltage category III.
74	External load and emission control measures to be used for test purposes	Intended heater

[a]For the purpose of the tests specified in Section "Electromagnetic compatibility (EMC) requirements – Immunity" of UL 60730-1, the products covered by this Standard should be considered as:

a) Installation Class 3 (See Explanatory notes for surge immunity test, UL 60730-1);

b) Overvoltage Category III

c) Test Level 3

21 Electrical Spacings

21.1 The spacings in a heater or remote control assembly shall be in accordance with Tables 21.1 and 21.2.

Exception: The spacing requirements in Tables 21.1 and 21.2 do not apply to the inherent spacings of a component, as such spacings are evaluated under the individual requirements for the component; however, the electrical clearance resulting from the assembly of the component into the heater unit, including spacings from parts of such a component to a dead-metal part or enclosure, shall be as indicated in the tables.

Table 21.1
Minimum spacings at field-wiring terminals and at fuseholders and thermal cutoffs

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

NOTE – These spacings do not apply to connecting straps or busses extending away from wiring terminals, fuseholders, or thermal cutoffs. Such spacings are evaluated under Table 21.2. This table applies to the sum of the spacings involved where an isolated dead-metal part is interposed. These spacings apply with fuses installed in the fuseholders. The spacings given in Table 21.2 apply when fuses are being installed, one at a time. Spacings in a low-voltage circuit may be not less than 1/4 inch (6.4 mm).

[a] 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 wiring compartment or terminal box, if the compartment or box is integral with a motor.

Table 21.2
Minimum spacings through air or over the surface at points other than field-wiring terminals, fuseholders, or thermal cutoffs

Parts involved	Potential involved, volts	(Inch)	(mm)
Between uninsulated live parts of opposite polarity; and between an uninsulated live part and a dead-metal part, other than the enclosure, that either is exposed to contact by persons or may be grounded	0 – 250 251 – 600	(1/16)[a] (1/4)[b,c]	(1.6)[a] (6.4)[b,c]
Between a live part and the enclosure	0 – 600	(1/4)[a]	(6.4)[a]

NOTE – When an uninsulated live part is not rigidly supported, or when a moveable dead-metal part is in proximity to an uninsulated live part, the construction shall be such that at least the minimum spacing is maintained under all operating conditions and under all conditions of handling.

[a] No minimum spacing requirements apply to a low-voltage circuit unless a short-circuit or ground results in a risk of fire or electric shock. When a ground results in such risk, the spacing between uninsulated live parts of opposite polarity, and between a rigidly mounted uninsulated live part and a dead-metal part, other than an enclosure that is exposed to contact by persons or may be grounded, shall not be less than 1/32 inch (0.8 mm), and the spacing between the live part and the enclosure shall not be less than 1/8 inch (3.2 mm).

[b] Enamel insulated wire is determined to be an uninsulated live part.

[c] A spacing of 1/16 inch (1.6 mm) is permissible at the heating element only, in a heater rated for 300 volts or less.

21.2 At closed-in points only (such as in 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 250 volts or less.

21.3 An insulating lining or barrier of fiber or similar material, used where spacings would otherwise be less than the required values, shall not be less than 1/32 inch (0.8 mm) thick, and shall be located or of such material so that it will not be adversely affected by arcing. Fiber not less than 1/64 inch (0.4 mm) thick may be used in conjunction with an air spacing of not less than half the spacing that would be required for air alone.

Exception: Insulating material having a thickness less than specified may be used if, upon investigation, it is determined to have properties equivalent to the material described in this paragraph.

21.4 Unless protected from mechanical damage during assembly and normal functioning, a barrier of mica shall not be less than 0.01 inch (0.25 mm) thick.

22 Clearance and Creepage Distances

22.1 As an alternative approach to the spacing requirements specified in Electrical Spacings, Section 21, and other than as noted in 22.2 and 22.3, clearances and creepage distances may be evaluated in accordance with the requirements in the Standard for Insulation Coordination Including Clearance and Creepage Distances for Electrical Equipment, UL 840, as described in 22.4.

22.2 Clearances between an uninsulated live part and the walls of a metal enclosure, including fittings for conduit or armored cable, shall be as noted in Table 21.2. The clearances shall be determined by physical measurement.

22.3 The clearance and creepage distance at field wiring terminals shall be in accordance with the requirements in Table 21.1.

22.4 In conducting evaluations in accordance with the requirements in the Standard for Insulation Coordination Including Clearance and Creepage Distances for Electrical Equipment, UL 840, the following guidelines shall be used

a) For evaluating clearances:

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

2) The Phase-to-Ground Rated System Voltage used in the determination of Clearances shall be the equipment rated supply voltage rounded to the next higher value.

3) To determine equivalence with current through air spacings requirements an impulse test potential having a value as determined in the Standard for Insulation Coordination Including Clearance and Creepage Distances for Electrical Equipment, UL 840, is to be applied.

b) For evaluation of creepages

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

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

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

i) A coating which complies with the requirements for Conformal Coatings in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, or

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

23 Protection Against Risk of Physical Injury

23.1 General

23.1.1 An edge, projection, or corner of an enclosure, opening, frame, guard, knob, handle, or the like shall be smooth and rounded, and shall not result in a cut-type injury when contacted during normal use or user maintenance.

23.2 Maximum surface temperatures

23.2.1 During the temperature test, the temperature of a surface that may be contacted by the user shall not be more than the values given in Table 23.2.1. If the test is conducted at a room temperature of other than 25°C (77°F), the results are to be corrected to that temperature.

Table 23.1
Maximum surface temperature

Surface material	°C	(°F)
Bare or painted material	67	(153)
Glass	78	(172)
Plastic[a]	83	(181)

[a] Includes plastic with a metal plating not more than 0.005 inch thick; and metal with a plastic or vinyl covering not less than 0.005 inch thick.

23.3 Stability

23.3.1 The stability of a heater shall be such that it cannot be readily overturned in normal use.

23.3.2 The stability of a heater is to be investigated only if it has flexible water connections, and if the height of the center of gravity of the filled heater above the supporting surface is greater than twice the smallest dimension of the base. See Stability Test, Section 37.

23.3.3 Stability requirements do not apply to a heater intended for permanent, reliable attachment to structures, if the instructions furnished with the heater clearly detail the intended method of installation.

24 Pressure Vessels and Parts Subject to Pressure

24.1 A heater that may be subject to pressure in normal use, indicated by instructions for placing a shut-off valve between the heater and pool or tub in accordance with the Exception to 42.6, shall comply with the requirements in this section.

24.2 A water heater shall be subjected to a 15-minute application of a hydrostatic pressure equal to two times the marked maximum working pressure, as described in Hydrostatic Pressure, Section 33.

Exception: Tanks marked with an appropriate boiler and pressure vessel code symbol of the American Society of Mechanical Engineers (ASME) and having a tank marked with not less than the marked maximum working pressure of the water heater need not be subjected to the hydrostatic pressure test.

25 Units Intended for Outdoor Use

25.1 General

25.1.1 A heater intended to be used where it will be exposed to the weather shall comply with this section as well as with the other applicable requirements of this standard.

25.2 Enclosure

25.2.1 An enclosure shall be constructed so that it will reduce the risk of the wetting of any live part as specified in 25.2.2 – 25.2.6, and will also reduce the risk of the electrical system becoming the source of electric shock due to weather exposure.

25.2.2 To determine compliance with the requirement in 25.2.1, a complete assembly, with supply conduit connections but without pipe thread compound, is to be subjected to the rain test described in Hydrostatic Pressure, Section 33.

25.2.3 A panel or cover in the outer enclosure shall require the use of tools to open unless it can be determined that removal or opening of the panel or cover will not increase the risk of electric shock due to weather exposure, or personal injury due to moving parts.

25.2.4 A hinge or other attachment shall be resistant to corrosion.

25.2.5 An enclosure for electrical components shall have provisions for drainage if there are knockouts or unthreaded openings in the enclosure.

25.2.6 A sheet steel cabinet or enclosure shall not be less than 0.032 inch (0.81 mm) thick if uncoated, and not less than 0.034 inch (0.86 mm) thick if zinc-coated.

Exception: A thinner enclosure than specified in this requirement is not prohibited from being used when it complies with Table 5.1 and is protected by an outer cabinet. A steel cabinet or enclosure using panels of more than one sheet of lesser thickness than specified is to be used when the construction is equivalent in all aspects, including mechanical strength and corrosion resistance, to a single sheet of the thickness stated.

25.3 Corrosion resistance

25.3.1 A heater intended for use where exposed to the weather shall comply with all three of the following requirements:

a) It shall not use metals in combinations that could result in galvanic action that may adversely affect any part.

b) Its enclosure shall be resistant to corrosion as specified in 25.3.2 – 25.3.9.

Exception: Item (b) does not apply to a metal part that is not required to form part of the enclosure.

c) If exposure to the earth or other corrosive agent(s) is anticipated, its metals or finishes shall be subjected to an investigation to determine acceptability under those conditions.

25.3.2 Aluminum, brass, copper, or stainless steel are capable of being used without additional corrosion resistance.

25.3.3 A nonmetallic enclosure or enclosure material shall be evaluated to determine the effects of exposure to ultraviolet light and water.

25.3.4 An enclosure of sheet steel less than 0.126 inch (3.2 mm) thick if zinc-coated, or 0.123 inch (3.12 mm) thick if uncoated, shall be protected against corrosion by one of the following means or by other metallic or nonmetallic coating(s) as described in 25.3.8.

a) Hot-dipped, mill-galvanized sheet steel conforming with the coating designation G90 in the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side based on the minimum single-spot test requirement in this ASTM Designation. The weight of the zinc is to be determined by any convenient method, but in case of question it shall be established in accordance with the Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M.

b) A zinc coating, other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 inch (0.0155 mm) on each surface, with a minimum thickness of 0.00054 inch (0.0137 mm). The thickness of the coating shall be determined by the test described in 34.1. An annealed coating shall also comply with 25.3.9.

c) A zinc coating conforming with 25.3.6 (a) or (b) with one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. The integrity of the paint is determined by evaluating its composition or by corrosion tests, when required.

d) A cadmium coating not less than 0.001 inch (0.025 mm) thick on both surfaces. The thickness of the coating shall be established by the test described in 34.1.

e) A cadmium coating not less than 0.00075 inch (0.0191 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.00051 inch (0.0130 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium shall be established by the test described in 34.1, and the paint shall be as specified in 25.3.4(c).

25.3.5 An enclosure of cast iron at least 1/8 inch (3.2 mm) thick is determined to be protected against corrosion when it has at least one coat of either organic finish of the epoxy or alkyd-resin type or outdoor paint on each surface. The integrity of the paint is to be determined by evaluation of its composition or by comparative corrosion tests, when required.

25.3.6 An enclosure of sheet steel not less than 0.126 inch (3.2 mm) thick if zinc coated or 0.123 inch (3.12 mm) thick if uncoated, or heavier, shall be protected against corrosion by one of the following means or by other metallic or nonmetallic coating(s) shown to give equivalent protection as described in 25.3.8.

a) Hot-dipped, mill-galvanized sheet steel conforming with the coating Designation G60 or A60 in the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single-spot test requirement in this ASTM Designation. The weight of zinc coating is to be determined by any method; however, in case of question, the weight of the coating shall be determined in accordance with the Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M. An A60 (alloyed) coating shall also comply with 25.3.9.

b) A zinc coating other than that provided on hot-dipped, mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 inch (0.0104 mm) on each surface with a minimum thickness of 0.00034 inch (0.0086 mm). The thickness of the coating shall be determined by the test described in 34.1. An annealed coating shall also comply with 25.3.9.

c) Two coats of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. The integrity of the paint is to be determined by evaluation of its composition or by corrosion tests, when required.

d) Any one of the means specified in 25.3.4.

25.3.7 The requirements in 25.3.6 also apply to sheet steel 0.056 inch (1.422 mm) thick if zinc coated, or 0.053 inch (1.346 mm) thick if uncoated, or heavier, used for an enclosure to be mounted within and protected from direct exposure to weather by the enclosure of other equipment. Such an inner enclosure shall not be marked ″Rainproof″ or ″Raintight.″

25.3.8 Other finishes, including paints, special metallic finishes, and combinations of the two, are capable of being used if comparative tests with galvanized sheet steel (without wiping, annealing, or other surface treatment) conforming with 25.3.4(a) or 25.3.6(a), as applicable, indicate that these provide equivalent protection. In evaluating such systems of coating consider:

a) Exposure to salt spray;

b) Moist carbon dioxide-sulphur dioxide-air mixtures;

c) Moist hydrogen sulphide-sulphur dioxide-air mixtures;

d) Moist hydrogen sulphide-air mixtures;

e) Ultraviolet light; and

f) Water.

25.3.9 A hot-dipped, mill-galvanized A60 (alloyed) coating or an annealed zinc coating that is bent or similarly formed after annealing, and that is not otherwise required to be painted, shall be painted in the bent or formed area if the bending or forming process damages the zinc coatings. The zinc coating is considered damaged when flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification.

Exception No. 1: Simple sheared or cut edges and punched holes are not determined to be formed.

Exception No. 2: Areas on the inside surface of an enclosure that water does not enter during the rain test are not required to comply with the painting requirement in this paragraph.

PERFORMANCE

26 Power Input

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

26.2 To determine whether a heater complies with 26.1, the power input is to be measured with the heater operating at normal operating temperature under full-load conditions while connected to a supply circuit adjusted to be the highest of the following:

a) The marked voltage rating or

b) The highest voltage of the applicable range of voltages specified in 38.2, if the marked voltage is within one of those ranges.

26.3 When an appliance uses a nonmetallic heating element such as carbon, the power input is to be determined using a new element.

27 Normal Temperature

27.1 A heater, when tested as described in this section, shall not attain a temperature at any point that will constitute a risk of fire or to adversely affect any material used in the heater, nor to show temperature rises at specific points greater than those indicated in Table 27.1.

Table 27.1
Maximum temperature rises

Materials and component parts	°C	(°F)
1. Any point within a wiring compartment in which field-installed conductors are to be connected, including such conductors themselves, unless the appliance is marked in accordance with 40.2.2	35	(63)
2. Fuses other than Classes CC, G, J, and T	65	(117)
3. Fuses, Classes CC, G, J, and T	85	(153)
4. Fiber used as electrical insulation or as bushings	65	(117)
5. Wood or other combustible material that is part of a heater	65	(117)
6. Class 105 insulated relay or solenoid or transformer winding	65[a]	(117)[a]
7. Class 130 (Class B) insulation system, except as indicated in items 8 and 9		
Thermocouple method	85	(153)
Resistance method	105	(189)
8. Transformer windings:		
Class 155 insulation; Class 2 transformers		
Thermocouple method	95	(171)
Resistance method	115	(207)
Power Transformers		
Thermocouple method	110	(198)
Resistance method	115	(207)
9. Transformer windings:		
Class 180 insulation; Class 2 transformers		
Thermocouple method	115	(207)
Resistance method	135	(243)
Power Transformers		
Thermocouple method	125	(225)
Resistance method	135	(243)
10. Phenolic composition used as electrical insulation or where breakdown would result in a risk of fire, electric shock, or injury to persons[b]	125	(225)
11. Insulated wire or cord	25°C (45°F) less than its temperature rating[c]	
12. Sealing compound	d	d
13. Copper conductors:		
a) Tinned or bare strands having:		
1. A diameter less than 0.015 inch (0.38 mm)	125	(225)
2. A diameter of 0.015 inch or more	175	(315)
b) Plated with nickel, gold, silver, or a combination of these	225	(405)
14. Termination of copper conductor in a pressure terminal connector, unless both are tinned, nickel-coated, or silver-plated	125	(225)
15. Plated iron or steel current-carrying part	100	(212)

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

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

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

Table 27.1 Continued on Next Page

Table 27.1 Continued

Materials and component parts	°C	(°F)
[d] Unless the material is thermosetting, 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 Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus, ASTM E28.		

27.2 All values in Table 27.1 are based on an assumed ambient temperature of 25°C (77°F), but the test may be conducted at any ambient within the range of 10 – 40°C (50 – 104°F). However, no observed temperature higher than 25°C (77°F) plus the specified maximum rise is acceptable if the operation of an automatic thermal control during the test limits the temperature under observation.

27.3 Temperatures are to be measured using thermocouples consisting of 24 – 30 AWG (0.21 – 0.05 mm^2) wires, and it is standard practice to use thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer-type instrument. Such equipment is to be used whenever referee test measurements are required.

Exception: If a coil is inaccessible for mounting thermocouples, its temperature is to be determined by the change-of-resistance method.

27.4 A temperature is determined to be constant when three successive readings, taken at intervals of 10 percent of the previously elapsed test duration, but not less than 5 minute intervals, show no change. The thermocouple wire is to conform with the requirements for special Special Tolerances thermocouples 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.

27.5 A thermocouple junction and adjacent lead wires are to be held in thermal contact with the surface of the material being measured. In most cases, thermal contact will result from taping or cementing the thermocouple in place, but if a metal surface is involved, brazing or soldering it in place may be required.

27.6 At a point on the surface of a Class 105 insulated relay or solenoid or transformer winding (Item 6 of Table 27.1), where the temperature is affected by an external source of heat, the temperature rise measured by the thermocouple may be 15°C (27°F) higher than the maximum indicated in Table 27.1 if the temperature rise measured by the change-of-resistance method is not greater than specified in the table.

27.7 To determine compliance with 27.1, the heater is to be operated continuously until constant temperatures have been attained. The test voltage is to be as specified in 26.2 and 27.8.

27.8 The test voltage specified in 26.2 is to be increased, if required, so as to result in the wattage input to be equal to the wattage rating marked on the heater.

27.9 For the normal temperature test, the heater is to be tested under conditions approximating those of normal operation. It is to be supported on a nominal 3/8-inch (9.5-mm) thick horizontal, black painted, softwood surface covered with two layers of white tissue paper. It is to be placed in a wall angle of 90 degrees formed by two black painted, vertical surfaces of nominal 3/8-inch thick plywood having width and height such that they extend not less than 2 feet (610 mm) beyond the physical limits of the heater. The heater is to be located as closely to the sides of the wall angle as its construction will permit so that maximum heating of the walls will occur. Temperatures are to be taken on nearby surfaces, on the supporting surface, at points of support, and at other points as required, including wiring in and to the heater.

27.10 Unless it has been determined that it is likely to remain in position during the handling of the heater prior to and during installation as well as 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.

27.11 For the temperature tests, the heater is to be connected with wires sized in accordance with Field-Wiring Connections, Section 7.

27.12 The cold water supply to the heater is to be at the temperature obtained from the local water mains.

27.13 With the regulating control set to give the maximum water temperature, the heater is to be operated until constant temperatures are attained. Unless a heater involves unusual construction features, it is to be assumed that temperatures have stabilized after the heater has been operating for 7 hours.

28 Water Temperature

28.1 With all controls in the circuit, and the regulating control set to maximum temperature, the heater is to be operated as described in Normal Temperature, Section 27. The water flow through the heater is to be adjusted to the minimum water flow recommended in the heater operating instructions. This flow rate is to be further reduced (when required) to attain the operation of the regulating control. The results are in compliance when the water temperature reading of the outlet water is 50°C (122°F) or less.

28.2 To determine compliance with 20.1, the heater is to be operated as described in Normal Temperature, Section 27, and the temperature of the water at the outlet is to be measured with a mercury thermometer. The regulating control is to be shunted, or the heater otherwise wired, so that the limiting control will be the only device in the circuit that will limit the temperature of the water. The water flow through the heater is to be reduced (when required) to attain the operation of the limiting control within 1 hour from the shunting out of the temperature regulating control. The results are in compliance when the water temperature reading is 70°C (158°F) or less.

29 Dielectric Voltage-Withstand

29.1 A heater shall be subjected to the application of a 60-hertz, essentially sinusoidal potential as indicated in 29.2 for 1 minute between live parts and dead-metal parts, with the heater at the operating temperature reached in normal use. The test potential is to be 1000 volts for a heater rated 250 volts or less, and 1000 volts plus twice the rated voltage for a heater rated more than 250 volts. The results are in compliance when there is no electrical breakdown.

29.2 To determine compliance with 29.1, the heater is to be tested by means of a 500 volt-ampere or larger capacity transformer, the output voltage of which can be regulated. Starting at zero, the applied potential is to be increased until the required test value is reached, and is then to be held at thatvalue for 1 minute. The increase in the potential is to be at a substantially uniform rate, and is to be as rapid as is consistent with the correct indication of the voltmeter. During the test, the heater is to be full of water, and all plumbing connections are to be attached to the water system.

30 Abnormal Operation

30.1 When the conditions of normal operation are not representative of abnormal conditions likely to be encountered in actual service, a heater shall be tested to determine whether it could result in a risk of fire, electric shock, or injury to persons when operated under such abnormal conditions.

30.2 To determine if a risk of fire could result, a separate abnormal heating test is to be conducted with the heater operating dry, and with the regulating control shunted. Only the limit control is to remain as a functioning temperature control device.

30.3 In the condition specified in 30.2, the heater is to be energized until the ultimate result has occurred, but not more than 7 hours.

31 Insulation Resistance as a Result of Moisture

31.1 A heater using insulation likely to be affected adversely by moisture under conditions of normal use shall be conditioned for 24 hours in air having a relative humidity of 85 ±5 percent at a temperature of 32 ±2°C (89.6 ±3.6°F). The results are in compliance when, after the conditioning, the heater has an insulation resistance of not less than 50,000 ohms between live and dead-metal parts.

31.2 Insulation resistance is to be measured by means of a voltmeter having an internal resistance of 30,000 ohms, and using a 250-volt direct current.

32 Resistance to Rain

32.1 A heater intended for outdoor use shall be subjected to the rain test. The maximum resistivity of the water used in the resistance to rain test shall be 2540 ohm-centimeters or minimum conductivity of 3.94×10^{-4} Siemen per centimeter (S/cm). The results of the test are to be used if the unit:

a) Has an insulation resistance of not less than 50,000 ohms when measured in accordance with Insulation Resistance as a Result of Moisture, Section 31;

b) Complies with a repeated dielectric voltage-withstand test as described in Dielectric Voltage-Withstand, Section 29; and

c) Complies with 32.6.

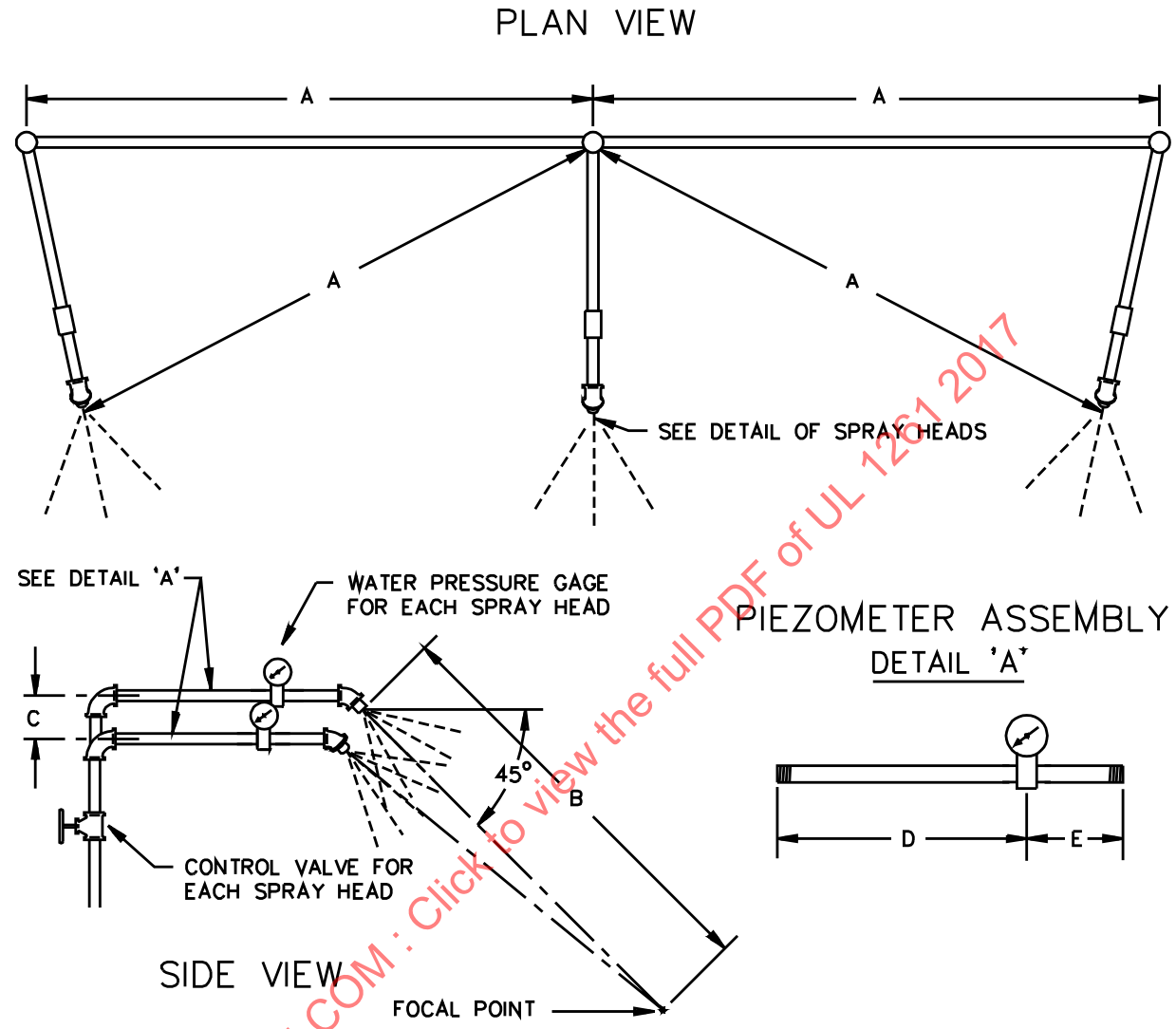
32.2 The rain test is to be conducted under normal conditions of operation most likely to permit entrance of water into or onto the electrical components. When required, operate the heater under various modes of operation or de-energize it if more adverse conditions result therefrom. In any case, each exposure to the simulated rain is to be for 1 hour. When more than one exposure is required, the unit is to be reconditioned as required so that the results of each test will not be influenced by prior exposures.

32.3 Field-wiring connections to the equipment are to be made to represent the intended method of such wiring. An opening at which conduit is to be terminated is to be sealed, but an opening for the entry of a conductor or conductors of a low-voltage circuit is not to be sealed. Water connections are to be made in the intended manner and according to the manufacturer's instructions.

32.4 The dielectric voltage-withstand and insulation resistance tests are to be repeated after each 1 hour exposure.

32.5 The rain test apparatus is to consist of three spray heads mounted in a water supply pipe rack as shown in Figure 32.1. Spray heads are to be constructed in accordance with the details shown in Figure 32.2. The water pressure for all tests is to be maintained at 5 pounds per square inch (34.43 kPa) at each spray head. The spray is to be directed towards the top and side of the assembly, which is to be centrally located within the spray pattern. The top of the unit is to be at least 3 feet (0.91 m) below the plane of the lower spray head outlet.

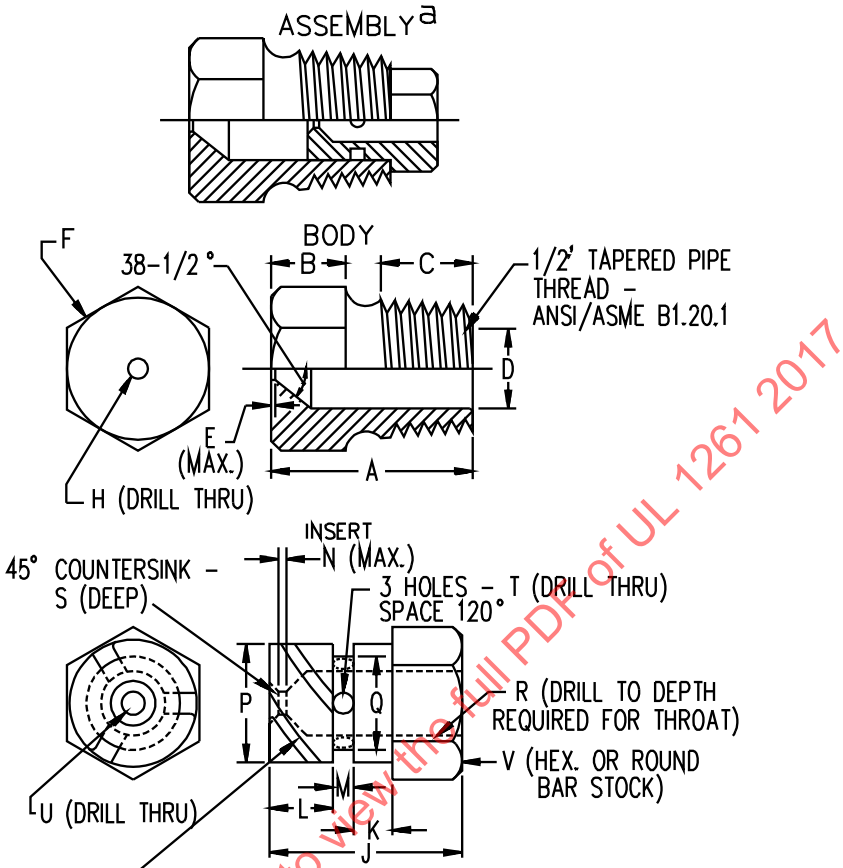
Figure 32.1
Spray head piping



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

RT101E

Figure 32.2
Spray head



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

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

[b] ANSI B94.11M Drill Size

[c] Optional - To serve as a wrench grip.

RT100E

32.6 The test is not to result in the entrance of water into enclosures above the lowest live part, or in wetting of any live part. The unit shall be disassembled (when required) to check compliance with this requirement.

Exception: Water is not prohibited from entering an enclosure above the lowest live electrical part when the point of entrance is not in proximity to such a live part, and no live part is wetted.

33 Hydrostatic Pressure

33.1 In accordance with the requirements in 24.2, a tank is to be filled with water so as to exclude air, and is to be connected to a hydraulic pump. The pressure is to be increased from atmospheric pressure to the test pressure specified in 24.2 at a rate of approximately 10 pounds per square inch per second (69 kilopascals per second). The results are in compliance when there is no rupturing or visible permanent distortion. Leakage at a gasket is not prohibited when it does not occur at a pressure lower than 70 percent of the required test value.

34 Metal Coating Thickness

34.1 The method of determining the thickness of zinc and cadmium coatings is to be as follows:

a) The solution is to be made from distilled water, and is to contain 200 grams per liter of chemically pure chromic acid (CrO_3) and 50 grams per liter of chemically pure concentrated sulphuric acid (H_2SO_4). The latter is equivalent to 27 milliliters per liter of chemically pure concentrated sulphuric acid, specific gravity 1.84, containing 96 percent H_2SO_4.

b) The test solution is to be contained in a glass vessel such as a separatory funnel with the outlet equipped with a stopcock and a capillary tube of approximately 0.025 inch (0.63 mm) inside bore and 5.5 inches (139.7 mm) long. The lower end of the tube is tapered to form a tip, the drops from which are about 0.05 milliliter each. To preserve an effectively constant level of solution, a small glass tube is inserted in the top of the funnel through a rubber stopper and its position is adjusted so that, when the stopcock is open, the rate of dropping is 100 ±5 drops per minute. If specified, an additional stopcock may be used in place of the glass tube to control the rate of dropping.

c) The sample and the test solution should be kept in the test room long enough to acquire the temperature of the room, which should be noted and recorded. The test is to be conducted at a room temperature of 21.1 – 32.0°C (70 – 90°F).

d) Each sample is to be thoroughly cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings are to be completely removed by means of solvents. Samples are then to be thoroughly rinsed in water and dried with clean cheesecloth. Care is to be taken to avoid contact of the cleaned surface with the hands or any foreign material.

e) The sample is to be supported from 0.7 to 1 inch (17.8 to 25.4 mm) below the orifice, so that the drops of the solution strike the point to be tested and run off quickly. The surface to be tested should be inclined about 45 degrees from horizontal.

f) After cleaning, the sample is to be put in place under the orifice. The stopcock is then to be opened and the time in seconds measured with a stop watch until the dropping solution dissolves off the protective metal and exposes the base metal. The end point for timing is the first appearance of the base metal recognizable by the change in color.

g) Each sample of a test lot is to be subjected to the test at three or more points, excluding cut, stenciled, and threaded surfaces, on the inside surface, and at an equal number of points on the outside surface, at places where the metal coating will probably be thinnest. On enclosures made from precoated sheets, the external corners that are subjected to the greatest deformation may have thin coatings.

h) To calculate the thickness of the coating being tested, the thickness factor is to be selected from Table 34.1 that corresponds to the temperature at which the test was conducted. This is to be multiplied by the time in seconds required to expose base metal.

Table 34.1
Values for coating thickness calculations

Temperature,		Thickness factors, 0.00001 inch (0.0003 mm) per second	
°F	°C	Cadmium platings	Zinc platings
70	21.1	1.331	0.980
71	21.7	1.340	0.990
72	22.2	1.352	1.000
73	22.8	1.362	1.010
74	23.3	1.372	1.015
75	23.9	1.383	1.025
76	24.4	1.395	1.033
77	25.0	1.405	1.042
78	25.6	1.416	1.050
79	26.1	1.427	1.060
80	26.7	1.438	1.070
81	27.2	1.450	1.080
82	27.8	1.460	1.085
83	28.3	1.470	1.095
84	28.9	1.480	1.100
85	29.4	1.490	1.110
86	30.0	1.501	1.120
87	30.6	1.513	1.130
88	31.1	1.524	1.141
89	31.7	1.534	1.150
90	32.2	1.546	1.160

35 Endurance of Temperature-Regulating and -Limiting Controls

35.1 A temperature control shall be subjected to an endurance test consisting of the number of cycles specified in Table 35.1. The results are in compliance when there is no electrical or mechanical breakdown of the control, nor significant burning, pitting, or welding of the contacts.

Table 35.1
Endurance test for temperature controls

Type of control	Number of cycles
Temperature-regulating	30,000
Automatic-reset, temperature-limiting	100,000
Manually-reset, temperature-limiting	1000 under load and 5000 without load
NOTE – The endurance test requirements also apply to a magnetic contactor or other auxiliary equipment used in conjunction with a temperature control.	

36 Leakage Current in Water

36.1 When an electric water heater is not provided with leakage current collectors of a type described in 9.2, the heater shall be tested in accordance with 36.2 – 36.7. The results are in compliance when the leakage current does not exceed 5.0 milliamperes.

36.2 For this test, the unit is to be supplied through an isolating transformer having a voltage and output current capacity to maintain a secondary voltage of 120 volts during the test. The test circuit is to be as shown in Figures 36.1 and 36.2. The impedance of the milliammeter (or millivoltmeter shunt) is not to exceed 50 ohms. As indicated in Figure 36.2, the ungrounded line terminal (or both, if there are two) for the equipment is to be connected to one end of the secondary winding, and the other end of the winding is to be connected to:

a) The enclosure ground terminal;

b) The neutral terminal; and

c) One side of the measuring circuit.

Figure 36.1
Electrode location and set-up

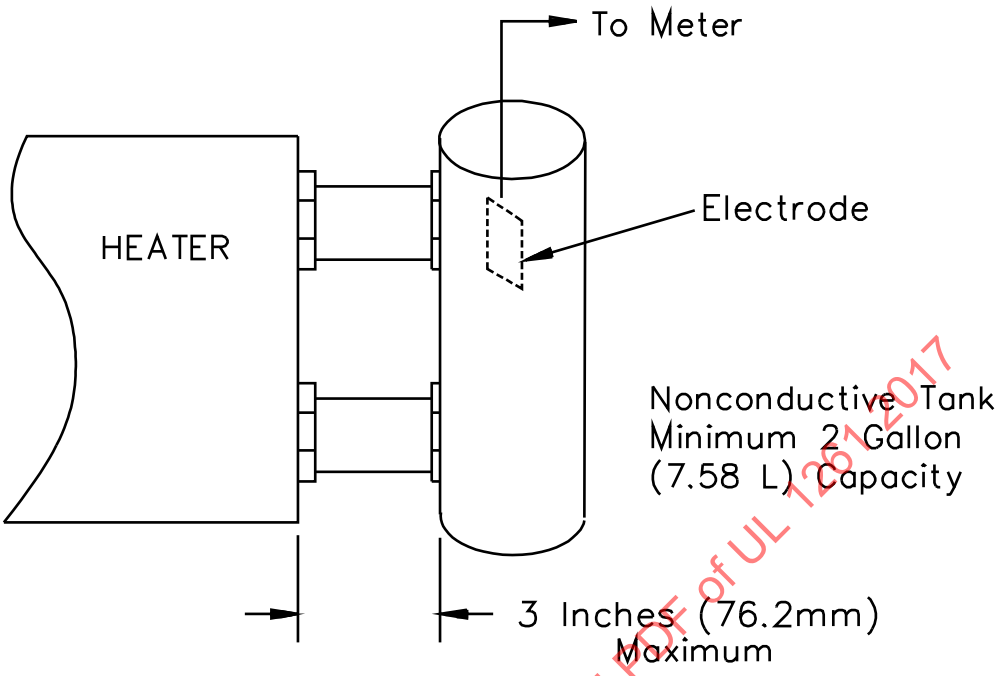
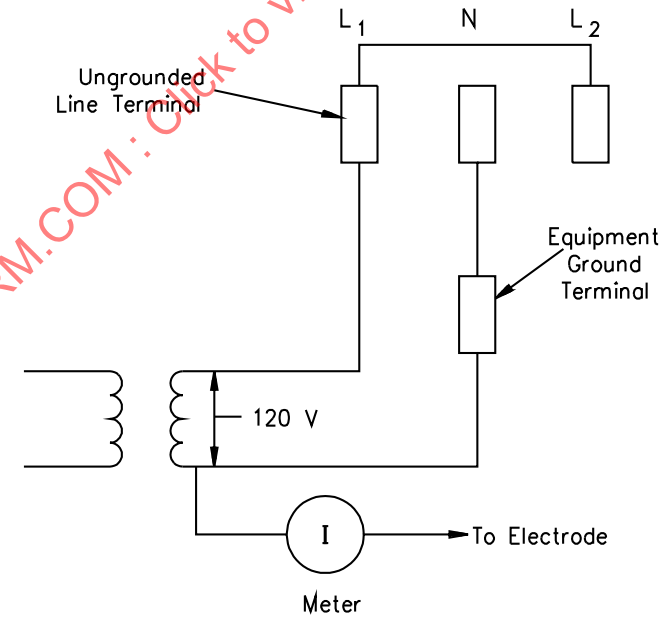


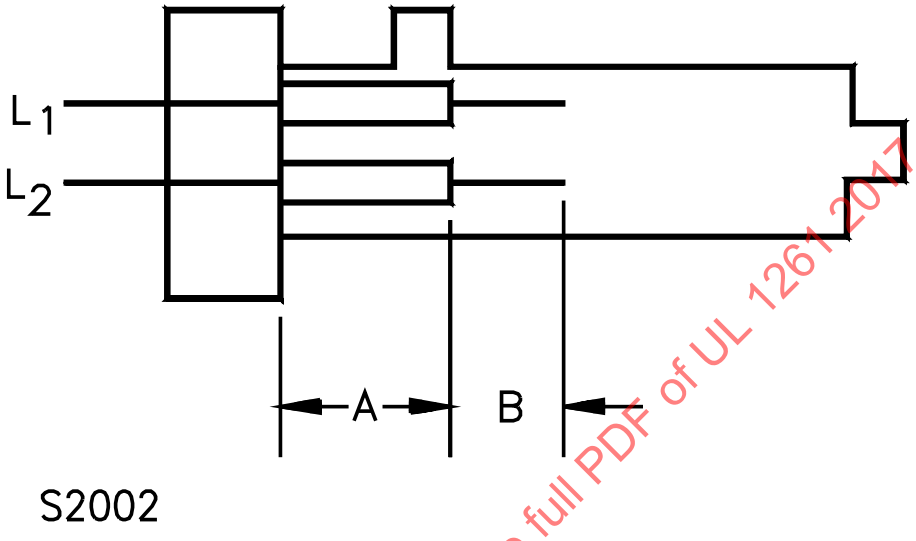
Figure 36.2
Test circuit connections



240 V connection shown. For 120 V connection eliminate L_2.

36.3 The heating element is to be altered to meet the description given in Figure 36.3 so that approximately 1 inch (25.4 mm) of the heating element conductor connected to each heater terminal is exposed to contact with the water in the circulating system. The water is to have a resistivity of 300 ohm-centimeters at a 25°C (77°F) ambient temperature.

Figure 36.3
Altered element



A – Element sheath length: 2 inches (50.8 mm)

B – Element conductor exposure length: 1 inch (25.4 mm)

36.4 Measurements are to be made with the water heater isolated from ground. The test tank and assembly are to be of insulating material with any metal hardware insulated from ground. The connection of noncurrent-carrying metal to the equipment grounding terminal is not to be disturbed, and any protective devices are to remain in the circuit.

36.5 Water pipe connections between the heater tank and the test tank are to be not more than 3 inches (76.2 mm) long and are to be of the same diameter as the water tank openings.

36.6 The current flow is to be measured to a copper electrode plate having dimensions approximately twice the internal diameter of the pipes through which the water circulates in the pool or tub. The electrode is to be placed inside the test tank as shown in Figure 36.1. The leakage current measurements are to be made one at a time with the electrode positioned 1 inch (25.4 mm) from and directly over each water discharge and water pick-up port.

36.7 The construction of the unit is to provide a current path from the altered heating element described in 36.3 to the equipment grounding means required in 10.1.

37 Stability Test

37.1 When tested in accordance with 37.2 – 37.4, an electric water heater shall not overturn.

37.2 A product is not to be energized during the stability test. The test is to be conducted under conditions which are most capable of overturning the product. The following conditions are to be such as to render the product most unstable:

a) Position of all doors, casters, and other movable or adjustable parts, including that of the flexible conduit resting on the surface supporting the product;

b) Connection or omission of any attachment made available or recommended by the manufacturer;

c) Direction in which the product is tipped or the supporting surface is inclined.

37.3 In conducting the stability test, the base, wheels, or legs are to be blocked to prevent the product from sliding. The product is to be placed on a plane inclined at an angle of ten degrees from the horizontal, or tipped through an angle of ten degrees from an at rest position on a horizontal plane.

37.4 A product with an integral tank is to be tested with the tank full or empty, whichever is a more adverse condition.

MANUFACTURING AND PRODUCTION-LINE TEST

38 Production-Line Dielectric Voltage-Withstand

38.1 General

38.1.1 As a routine production-line test, each heater unit shall be subjected to the application of a 40 – 70 hertz potential between:

a) The primary wiring, including connected components, and accessible dead-metal parts that will become energized and

b) Primary wiring and accessible low-voltage (42.4 volts peak or less) metal parts, including terminals.

The results are in compliance when there is no electrical breakdown.

38.1.2 The production line test is to be in accordance with either Condition A (1 second application) or Condition B (60 second application) of Table 38.1.

Table 38.1
Production-line test conditions

Rating of heater	Condition A		Condition B	
	Potential, volts	Time, seconds	Potential, volts	Time, seconds
250 volts or less	1000	60	1200	1
More than 250 volts	1000 + 2V[a]	60	1200 + 2.4V[a]	1
[a] V is the maximum marked voltage of the heater.				

38.1.3 The unit may be in a heated or unheated condition for the test.

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

Exception No. 1: A part such as a snap cover or friction-fit knob that can interfere with performance of the test is not required to be in place.

Exception No. 2: The test may be performed before final assembly when the test represents that for the complete appliance.

38.1.5 A heater using a solid-state component that is not relied upon to reduce a risk of electric shock, and that can be damaged by the dielectric potential, may be tested before the component is electrically connected if a random sampling of each day's production is tested at the potential specified in Table 38.1 with the component in the circuit. The circuitry may be rearranged for the purpose of the test to reduce the risk of solid-state component damage while retaining representative dielectric stress of the circuit.

38.2 Test equipment

38.2.1 The test equipment is to include:

a) A transformer having an essentially sinusoidal output;

b) A means of indicating the test potential;

c) An audible or visible indicator of electrical breakdown; and

d) Either a manually-reset device to restore the equipment after electrical breakdown, or an automatic-reject feature that rejects any unacceptable unit.

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

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

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

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

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

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

38.2.4 Test equipment other than as described in 38.2.1 – 38.2.3 is not prohibited from being used when determined to accomplish the intended factory control.

38.2.5 During the test, the primary switch is to be in the on position, both sides of the primary circuit of the heater are to be connected together and to one terminal of the test equipment, and the second test equipment terminal is to be connected to the accessible dead-metal.

Exception No. 1: A heater (resistive, high-impedance winding, and the like) having circuitry not subject to excessive secondary-voltage build up in case of electrical breakdown during the test may be tested with a single-pole primary switch, if used, in the off position, or with only one side of the primary circuit connected to the test equipment when the primary switch is in the on position, or when a primary switch is not used.

Exception No. 2: The primary switch is not required to be in the on position if the testing means applies full test potential between primary wiring and dead-metal parts with the switch not in the on position.

RATINGS

39 Details

39.1 A heater shall be rated in amperes or watts, and also in volts, and may be rated for alternating-current only or direct-current only. The ratings shall include the number of phases if the unit is intended for use on a polyphase circuit. If frequency sensitive components or circuits are used, the ratings shall include the frequency (expressed in hertz or Hz).

39.2 The voltage rating shall be indicated as a single voltage or range of voltages such as 100 – 120, 208, 220 – 240, 254 – 277, 416, 440 – 480, 550, 575, or 600.

39.3 A heater may have more than one element, and be intended to positively prevent the use of more than one element at a time. If it is connected (with circuit interlocks) at the factory so that only one element can operate at a time, the current or wattage rating shall be on the assumption that the largest single such element will be the one operating.

MARKINGS

40 Details

40.1 Identification and electrical ratings

40.1.1 A heater shall be legibly and permanently marked with:

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

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

c) A distinctive catalog or model number or the equivalent; and

d) The electrical rating.

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

Exception No. 2: The date of manufacture may be abbreviated or in an established or otherwise accepted code.

40.1.2 The electrical rating specified in 40.1.1 shall include the wattage rating of each heating element used and the wattage rating or current consumption of the entire heater as described in 39.3. In the case of a heater intended for use only on alternating-current at a specific frequency, or on direct-current only, the rating shall include the type of supply current to be used. A two-wire heater, intended for use only on a three-wire, 125/250-volt system shall be marked "250 V 2-wire for use only on 125/250 V 3-wire system." A two-wire heater intended for connection to a 250 volt-to-ground system shall be marked "250 V 2-wire for use only on 250 volt-to-ground system."

40.1.3 A heating element replaceable in the field that is rated at more than 1 ampere shall be legibly marked with its electrical ratings in amperes or watts, and in volts.

40.1.4 A heater intended for use outdoors shall be marked "For outdoor use."

40.1.5 When a manufacturer produces or assembles heaters at more than one factory, each finished heater shall have a distinctive marking, which may be in code, by means of which it may be identified as the product of a particular factory.

40.1.6 A door or cover of a heater that necessitates servicing by the user, including replacement of a cartridge fuse, involving the exposure of any normally enclosed or guarded uninsulated live part to unintentional contact shall be legibly and permanently marked with a warning that such servicing should be done with the heater disconnected from the power supply circuit.

40.1.7 If the use of a water shut-off valve is indicated in the installation instructions in accordance with the Exception to 42.6, the water heater shall be legibly and plainly marked with the maximum working pressure.

40.2 Temperatures for field-wiring conductors

40.2.1 If any point within a terminal box or wiring compartment of a permanently-connected heater in which field-installed conductors are intended to be connected, including the conductors themselves, attains a temperature greater than 60°C (140°F) during the normal temperature test, the heater shall be marked in accordance with 40.2.2. The statement shall be legible and located so that it will be clearly visible during installation and examination of supply wiring connections.

40.2.2 The marking required by 40.2.1 shall be in accordance with 40.2.2 (a) – (c). The blanks in 40.2.2(a) and 40.2.2(c) shall be filled in with the applicable wire size, and the temperatures shall be as shown in Table 40.1.

a) If all the conductors used in the normal temperature test are the same size, the marking is to read ″For supply connections, use ____ AWG or larger wires suitable for at least ____°C (____°F)″ or equivalent wording. The conductor size shall not be less than the supply conductor size identified in 7.2.2.

b) If the test was made with 14 AWG (2.1 mm^2) conductors, the wire size portion of the marking shown in (a) is not required.

c) If conductors of more than one size were used in the normal temperature test (because of unbalanced loads, multiple power supplies, or other reason), the marking shall read ″For supply connections, use wires suitable for at least ___°C (___°F). See wiring diagram for wire sizes,″ or equivalent wording. The conductor size shall not be less than the supply conductor size identified in 7.2.2.

Table 40.1
Temperatures for marking

Temperatures attained in terminal box or compartment during normal temperature test				Temperature in marking,	
°C		°F			
More than	Not more than	More than	Not more than	°C	(°F)
60	75	140	167	75	(167)
75	90	167	194	90	(194)

40.3 Marking of field terminals

40.3.1 A field terminal of a heater shall be marked with the following (or equivalent statement): ″Use copper conductors only,″ or ″For use with aluminum or copper conductors.″ This marking shall be independent of any other marking on terminal connectors, and it shall be visible during and after installation of the heater.

41 Permanence

41.1 General

41.1.1 The markings required in MARKINGS, Details, Section 39, shall be permanent and located on a part that requires tools for removal or, when removed, impairs the operation of the heater.

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

a) Etched,

b) Molded,

c) Die-stamped,

d) Paint-stenciled,

e) Permanently secured, stamped or etched metal, or

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

Usage, handling, storage, and the like, of the heater is to be determined in evaluating the permanence of a marking.

41.1.3 To determine acceptability of the adhesion of a pressure-sensitive label, representative samples are to be subjected to the tests described in this section. In each test, samples of the label are to be applied to test surfaces as in the intended application.

41.2 Oven aging

41.2.1 Three samples of the test panels are to be placed in an air oven maintained at the temperatures indicated in Table 41.1 for 240 hours.

Table 41.1
Oven temperatures

Maximum normal operating temperature of surface of applied label,		Oven temperature,	
°C	(°F)	°C	(°F)
60	(140)	87	(189)
80	(176)	105	(221)
100	(212)	121	(250)
125	(257)	150	(302)
150	(302)	180	(356)

41.3 Immersion

41.3.1 Three samples of the test panels are to be placed in a controlled atmosphere maintained at 23.0 ±2.0°C (73.4 ±3.6°F) with a 50 ±5 percent relative humidity for 24 hours. These samples are then to be immersed in water at a temperature of 21.0 ±2.0°C (69.8 ±3.6°F) for 48 hours.

41.4 Standard atmosphere

41.4.1 Three samples of the test panels are to be placed in a controlled atmosphere maintained at 23.0 ±2.0°C (73.4 ±3.6°F) with a 50 ±5 percent relative humidity for 72 hours.

41.5 Evaluation of adhesive labels

41.5.1 Immediately following each environmental exposure as described in 41.2.1 – 41.4.1, and for 24 hours afterward, each sample shall:

a) Adhere without curling of the edges;

b) Resist defacement or removal as demonstrated by scraping across the test panel with a flat metal blade 1/32 inch (0.8 mm) thick with no sharp edges, held at a right angle to the test panel (during this test, the blade is to be pressed against the panel with a force of 5 pounds [22.24 N]); and

c) Retain legible printing and not be defaced by rubbing with finger pressure.