UL 1795

STANDARD FOR SAFETY

Hydromassage Bathtubs

UL Standard for Safety for Hydromassage Bathtubs, UL 1795

Fifth Edition, Dated September 2, 2016

Summary of Topics

This revision of UL 1795 is being issued to revise control requirements.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated October 20, 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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SEPTEMBER 2, 2016
(Title Page Reprinted: December 8, 2017)

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UL 1795

Standard for Hydromassage Bathtubs

First Edition – February, 1988
Second Edition – November, 1993
Third Edition – March, 1999
Fourth Edition – August, 2009

Fifth Edition

September 2, 2016

This UL Standard for Safety consists of the Fifth Edition including revisions through December 8, 2017.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover indoor hydromassage bathtubs, rated 250 volts or less, for household and commercial use, for permanent connection to the plumbing of the building. They are intended for either permanent connection to the electrical supply or are factory-provided with a cord terminating in an attachment plug, and are intended for installation and use in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements do not cover portable cord-connected hydromassage equipment, which is covered by the Standard for Personal Hygiene and Health Care Appliances, UL 1431, or hydrotherapy tubs, which are covered by the Standard for Medical Electrical Equipment, Part 1: General Requirements for Safety, UL 60601-1.

1.3 The majority of the requirements in this standard address complete hydromassage bathtubs, including field-installed accessories. The following sections specify requirements for field-installed accessory heaters evaluated and certified for the hydromassage bathtub manufacturer.

a) Hydromassage Bathtubs Configured for Field-Installed Heaters, (CONSTRUCTION) Section 26, and

b) Field-Installed Heaters, Section 27.

c) Test for Field-Installed Heaters, (PERFORMANCE) Section 67.

d) Hydromassage Bathtubs Configured for Field-Installed Heaters, (MARKINGS) Section 73, and

e) Field-Installed Heaters, Section 74.

2 Units of Measurement

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

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

3 Undated References

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

4 Glossary

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

4.2 ACCESSIBLE PART – A part located so that it can be contacted by a person, either directly or by means of a tool during user servicing, or that is not recessed the required distance behind an opening.

4.3 ACCESSIBLE TO THE OCCUPANT – Any surface or component within a 5-foot (1.52-m) reach path of the bathtub occupant.

4.4 ACCESSORY – An optional electrical component that is intended to be attached to the main equipment in the field or that may be shipped separately from the main equipment.

4.5 CLASS 2 CIRCUIT – A secondary circuit with an open circuit potential of no more than 30 volts rms (42.4 volts peak) supplied by either an inherently limited Class 2 transformer or by a transformer and fixed impedance that together comply with all performance requirements for inherently limited Class 2 transformers in 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.

4.6 CONFORMAL COATING – An insulating coating that conforms to the configuration of the object that is coated. The coating is used as a covering to protect against environmental conditions.

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

4.8 DEAD METAL – A metal part not connected to electrical circuitry and not intended to conduct current. Does not include an isolated metal name plate, cabinet trim, screws, or small metal hardware fastened to a nonconductive enclosure.

4.9 DOUBLE INSULATION – An insulation system comprised of basic insulation and supplementary insulation, with the two insulations physically separated and arranged so that they are not simultaneously subjected to the same deteriorating influences (temperature, contaminants, or the like) to the same degree.

4.10 DRY-FIRE PROTECTION – A device or circuit that de-energizes the heater whenever water circulation through the heater is interrupted.

4.11 ENCLOSURE – That part of a unit that:

a) Renders inaccessible any part that may present a risk of electric shock;

b) Prevents emission of flame or molten material; or

c) Prevents unintentional contact with internal parts that may involve a risk of injury.

Some examples are tub materials, skirting materials, service access covers, electrical boxes, and barriers.

4.12 FIELD-WIRING TERMINAL – A terminal or terminals to which the electrical supply is to be connected during installation of the unit.

4.13 HYDROMASSAGE BATHTUB – A permanently installed bathtub equipped with a recirculating piping system, a pump, and associated plumbing constructed to accept, circulate, and discharge water upon each use. Optional equipment such as control switches, timers, blowers, heaters, temperature controls, air bubblers, and luminaires may be provided. A hydromassage bathtub may be provided with an air blower and no recirculating pump.

4.14 INTERLOCK – A device, system, or circuit used to de-energize electrical components or stop moving parts that become exposed when an enclosure is opened or when a cover is removed.

4.15 ISOLATING TRANSFORMER – A transformer with one or more output windings electrically separated from the input winding and all other output windings.

4.16 LEAKAGE CURRENT COLLECTOR – Conductive metal in the circulating water system of a hydromassage bathtub that provides a path for leakage current to ground.

4.17 LIVE PART – A part at some potential with respect to another part, or to earth ground.

4.18 MAXIMUM NORMAL LOAD – A load that closely approximates the most severe conditions of normal use.

4.19 PRIMARY CIRCUIT – An input circuit that supplies energy to a product.

4.20 RISK OF ELECTRIC SHOCK – A risk of electric shock is considered to exist whenever the available current exceeds the limits specified in Table 4.1 when measured as described in the Available Current Test, Section 56. Other current waveforms than specified in Table 4.1 are considered to comply with the intent of this requirement if the maximum available current to ground does not exceed the startle current threshold and the maximum point-to-point current, when unreliable control isolation layers are removed, does not exceed the let-go current threshold as specified in IEC TS 60479-2, Effects of current on human beings and livestock – Part 2: Special aspects.

Table 4.1
Risk of electric shock limits

Location	Limit, milliamperes, 50 or 60 Hz AC	Limit, milliamperes, pure DC[b]
Current circulating in the water from two points immersed in the water	0.5	2.0
Bathtub water and ground	0.5	2.0
Any point accessible to the bathtub occupant and ground	0.5	2.0
Any point on the bathtub control and ground[a]	0.5	2.0
Any two points on the bathtub control, or between two controls[a]	5.0	30.0
NOTE: The 0.5 and 2.0 mA limits specified correspond to the startle current threshold. The 5.0 and 30 mA limits specified correspond to the let-go current threshold.		
[a] The outer layer of a membrane switch shall not be relied upon for mitigation of the risk of electric shock.		
[b] DC current is considered to be pure dc only if it is confirmed through test that the peak-to-peak value of ripple in the current is not more than 10 percent of the dc current.		

4.21 RISK OF FIRE – A risk of fire is considered to exist if the available power at any point exceeds Class 2 levels as defined in 4.5.

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

4.23 SECONDARY CIRCUIT – A circuit derived from the secondary of an isolating transformer.

4.24 TRIP-FREE TEMPERATURE-LIMITING CONTROL – A control device constructed so that, regardless of the position of the actuating handle, button, or lever, the contacts cannot be held in the closed position when the water has attained a temperature hotter than specified.

4.25 UNIT – A term meaning a hydromassage bathtub.

4.26 USER SERVICING – Any form of servicing that may be performed by anyone other than qualified service personnel.

5 Accessories

5.1 An accessory for optional use shall comply with the applicable requirements of this standard and shall be constructed such that it can be used without alteration of wiring, enclosure, or other features of the main equipment depended upon to reduce the risk of fire, electric shock, or injury to persons. If the main equipment has provisions for electrical or mechanical connections to field applied accessories, such accessories shall be investigated with the main equipment and accompanied by installation instructions. An accessory that is made available or recommended by the manufacturer shall be investigated with the unit.

5.2 Each accessory connector shall be marked to indicate that the accessory is to be connected as specified in 71.13.

CONSTRUCTION

6 General

6.1 A unit shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it is likely to be subjected without introducing a risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

6.2 A hydromassage bathtub is not prohibited from:

a) Being provided as a completely enclosed unit;

b) Having only one finished side for built-in installations; or

c) Being without finished sides for custom installations.

6.3 A completely enclosed unit shall provide access for splice inspection and routine maintenance after final installation. A unit intended for built-in or custom installation shall include instructions that detail the access for splice inspection and routine maintenance after final installation. See 79.5.

7 Component Specifications

7.1 General

7.1.1 Except as indicated in 7.1.2, a component of a product covered by this standard shall comply with the requirements for that component as indicated in this Section.

7.1.2 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; or

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.

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

7.1.4 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.

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

a) Pollution Degree III installations.

Exception: Components installed so they reside entirely in the user (bathroom) side of the tub installation.

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

7.1.6 Components not anticipated by the requirements of this standard, not specifically covered by a component standard of Component Specifications, Section 7, 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.

7.2 Quick-connect wire connectors

7.2.1 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.

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

7.3 Terminal blocks

7.3.1 Terminal blocks shall comply with:

a) The Standard for Terminal Blocks, UL 1059;

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

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.

7.3.2 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.

7.3.3 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.

7.4 Wire connectors

7.4.1 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.

7.4.2 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.

7.5 Button or coin cell batteries of lithium technologies

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8 Frame and Enclosure

8.1 General

8.1.1 An enclosure shall be provided to house all parts that may cause a risk of fire, electric shock, or injury to persons under any condition of operation.

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

8.1.3 An enclosure containing an electrical component, other than a motor having a sealed housing, shall have provision for drainage if there is a knockout or unthreaded opening in the enclosure or if there is a risk of condensation accumulating.

8.1.4 The material of a part, such as an enclosure, a frame, or a guard, the breakage of which may result in a risk of injury to persons, shall have such properties as to meet the demand of expected loading conditions.

8.1.5 The requirement in 8.1.4 applies to those portions of a part adjacent to moving parts considered to involve a risk of injury to persons.

8.1.6 An enclosure shall be judged with respect to its size, shape, and thickness, considering the intended use. Sheet steel shall be not less than 0.026 inch (0.66 mm) thick if uncoated or 0.029 inch (0.74 mm) thick if galvanized. Nonferrous sheet metal shall be not less than 0.036 inch (0.91 mm) thick.

Exception: Any relatively small area or surface that is curved or otherwise reinforced may be thinner than specified if the construction results in equivalent strength and rigidity.

8.1.7 For unreinforced, flat surfaces in general, cast metal shall be no less than 1/8 inch (3.2 mm) thick, malleable iron shall be not less than 3/32 inch (2.4 mm) thick, and die-cast metal shall be not less than 5/64 inch (2.0 mm) thick.

Exception: Corresponding thicknesses of not less than 3/32, 1/16 (1.6 mm), and 3/64 inch (1.2 mm), respectively, are not prohibited from being used when the surface under consideration is curved, ribbed, or otherwise reinforced, or when the shape or size of the surface, or both, is such that the required physical strength is provided.

8.1.8 Among the factors taken into consideration when investigating a material used as an enclosure are its:

a) Physical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Combustibility;

e) Resistance to corrosion; and

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

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

8.1.9 All electrical parts shall be located or enclosed so as to reduce the risk of unintentional contact with any uninsulated live part or internal wiring.

8.1.10 Live parts shall be located at least 1-1/2 inches (38.1 mm) above the intended mounting surface.

8.1.11 Polymeric materials shall comply with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

Exception: A polymeric tub material of a hydromassage bathtub within which each electrical component is provided with a suitable electrical enclosure, as specified in Frame and Enclosure, Section 8, and Internal Wiring, Section 15, are not required to comply with the requirements in UL 746C.

8.1.12 The polymeric materials specified in 8.1.11, when molded or fabricated by a source other than the manufacturer, shall be identified according to the Standard for Polymeric Materials – Fabricated Parts, UL 746D.

8.2 Barriers

8.2.1 An opening in the bottom of the enclosure is not acceptable if the opening is located directly below field- or factory-made splices or overload or overcurrent protective devices.

8.2.2 A barrier of material that is resistant to combustion shall be provided:

a) Under a motor unless:

1) The structural parts of the motor or of the overall unit provide the equivalent of such a barrier; or

2) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the unit when the motor is energized under each of the following four fault conditions, applied separately:

i) Main winding opened;

ii) Starting winding opened;

iii) Starting switch short circuited; and

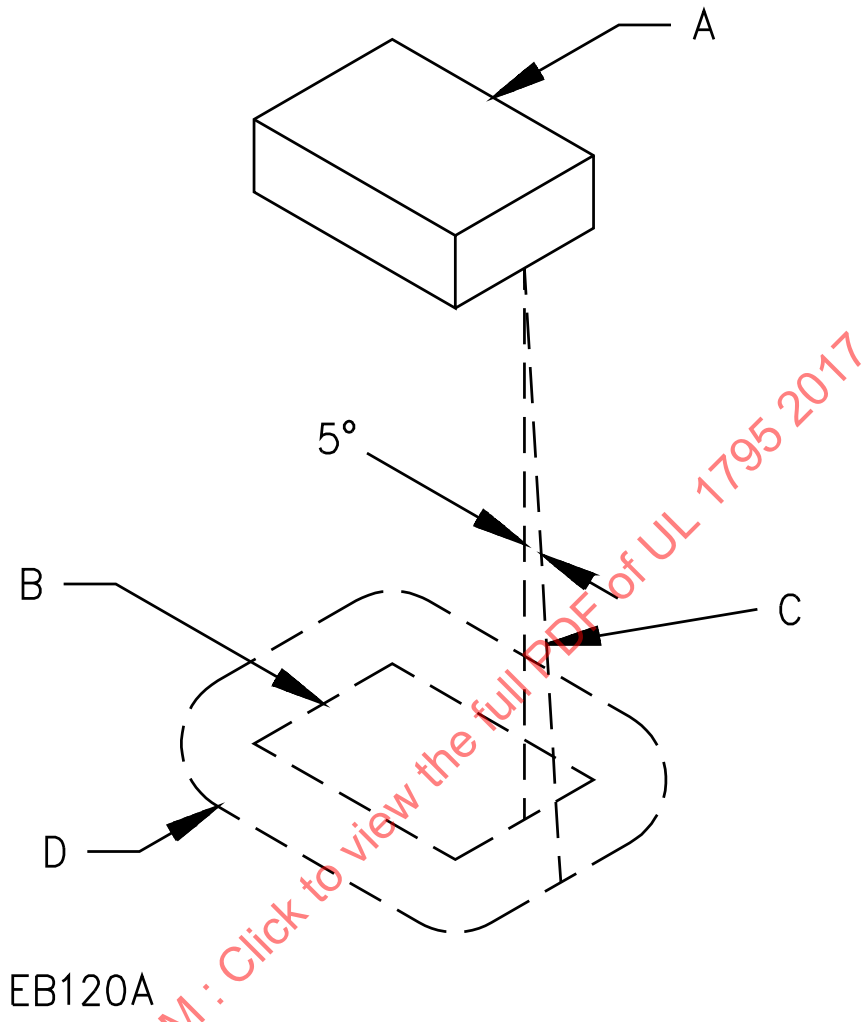
iv) For a permanent split-capacitor motor, the capacitor short circuited (the short circuit is to be applied before the motor is energized, and the rotor is to be locked); or

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

b) Under wiring unless it is of the flame retardant type. Neoprene- or thermoplastic-insulated wires are considered to be of this type.

8.2.3 The barrier specified in 8.2.2 shall be horizontal, located as indicated in Figure 8.1, and shall have an area no less than that described in Figure 8.1. Openings for drainage or ventilation may be provided in the barrier, provided that such openings will not permit molten metal or burning insulation to fall on combustible material.

Figure 8.1
Location and extent of barrier



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

B – Projection of outline of component on horizontal plane.

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

1) Tangent to the component;

2) 5 degrees from the vertical; and

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

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

8.2.4 A switch, transformer, relay, or solenoid is to be individually and completely enclosed other than at terminals, unless it can be shown that malfunction of the component will not result in a risk of fire, or unless there are no openings in the bottom of the enclosure.

8.2.5 The barrier specified in 8.2.2, if plastic, shall have a minimum rating of 5VA in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

8.3 Moving parts

8.3.1 The rotor of a motor, a pulley, a belt, a gear, or other moving part that could cause injury to persons shall be enclosed or guarded to reduce the likelihood of unintentional contact.

8.4 Button or coin cell batteries of lithium technologies

8.4.1 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.

9 Mechanical Assembly

9.1 General

9.1.1 A unit shall be assembled so that it will not be adversely affected by vibration. Motor brush caps shall be constructed so as not to loosen.

9.1.2 A unit shall be provided with an integral mounting means for the pump or air blower and shall be shipped from the factory with the pump or air blower mounted and plumbed in place.

Exception No. 1: The pump may be shipped with the bathtub but not secured or plumbed in place if the pump is provided:

a) With provision to be plumbed to the bathtub with threaded unions and the pump and bathtub are factory assembled with all appropriate fittings; and

b) In the same shipping container as the bathtub.

Exception No. 2: The bathtub is not required to be provided with a pump mounting platform if the pump is provided with an integral mounting base that can be secured with the use of screws.

Exception No. 3: The pump may be shipped separately from the bathtub if:

a) The pump is provided with provision to be plumbed to the bathtub with threaded unions and the pump and bathtub are factory assembled with all appropriate fittings; and

b) The bathtub is marked with the following or the equivalent, "Pump shipped separately. Complete unit includes pump(s) ____, Model ____." The blanks shall be filled in with the name of the manufacturer and model number for the pump(s).

Exception No. 4: Air blowers intended for field installation and that are part of optional kits may be mounted remote from the bathtub.

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9.2 Adhesive used to secure parts

9.2.1 An adhesive that is relied upon to reduce a risk of fire, electric shock, or injury to persons shall comply with the requirements for adhesives in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

9.2.2 The requirement in 9.2.1 applies to an adhesive used to secure a conductive part, including a nameplate, that may, if loosened or dislodged:

a) Energize an accessible dead-metal part;

b) Make a live part accessible;

c) Reduce spacings below the minimum values described in Spacings, Section 22;

d) Short circuit live parts; or

e) Bridge live parts to ground, to dead metal, or to a Class 2 or safety circuit.

9.2.3 All electrical components shall be mounted securely and shall be prevented from turning.

Exception No. 1: An electric switch is not required to be prevented from turning when:

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

b) The means of mounting the switch make it unlikely that operation of the switch will loosen it;

c) Electrical spacings are not reduced below the minimum required values if the switch rotates;

d) Strain is not transmitted to internal wiring; and

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

Exception No. 2: A lampholder with a nonreplaceable lamp need not be prevented from turning if:

a) Rotation cannot reduce electrical spacings below the minimum required values;

b) Strain is not transmitted to internal wiring; and

c) The rotation does not affect the integrity of a watertight enclosure.

9.2.4 An uninsulated live part shall be secured to its base or mounting surface so that it will be prevented from turning or shifting in position if such motion may result in a reduction of spacings below the minimum required values.

9.2.5 Friction between surfaces shall not be used as the sole means to prevent shifting or turning of live parts or shifting or turning of a device having a single-hole mounting means. A lock washer installed as intended may be used.

9.2.6 A unit is not prohibited from being shipped from the factory unassembled, or disassembled to the degree necessary to facilitate shipment, when:

a) All of the parts are furnished by the manufacturer;

b) Adequate electrical continuity is provided between the field-assembled components;

c) The equipment is constructed so that the field assembly can be accomplished without drilling, cutting, threading, or any other alteration other than the attachment of field-installed electrical conduit or raceway;

d) Detailed, step-by-step installation instructions are provided with the unit; and

e) All safety features are factory installed.

10 Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts

10.1 To reduce the risk of unintentional contact that may involve a risk of:

a) Electric shock from an uninsulated live part or film-coated wire; or

b) Injury to persons from a moving part, an opening in an enclosure shall comply with either (1) or (2).

1) For an opening that has a minor dimension as described in 10.5 of less than 1 inch (25.4 mm), an uninsulated live part, a moving part, or film-coated wire shall not be contacted by the probe illustrated in Figure 10.1.

2) For an opening that has a minor dimension as described in 10.5 of 1 inch or more, an uninsulated part, a moving part, or film-coated wire shall be spaced from the opening as specified in Table 10.1.

Exception: An opening in a motor is not required to comply with these requirements when it complies with the requirements in 10.2.

Figure 10.1
Accessibility probe

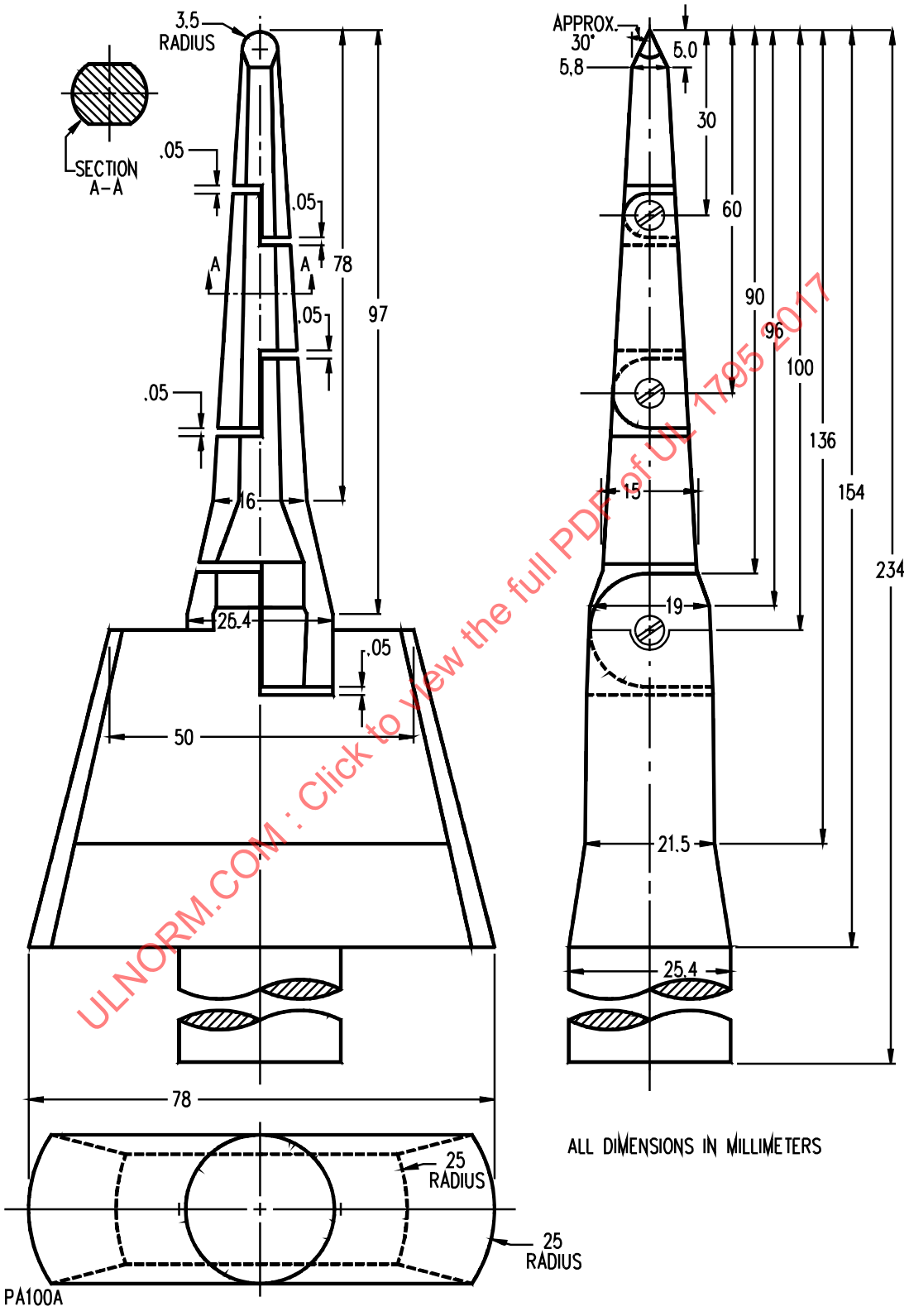


Table 10.1
Minimum distance from an opening to a part that may involve a risk of electric shock or injury to persons

Minor dimension[a] of opening, inches[b]	(mm)[b]	Minimum distance from opening to part, inches[b]	(mm)[b]
3/4[c]	(19.1)	4-1/2	(114.0)
1[c]	(25.4)	6-1/2	(165.0)
1-1/4	(31.8)	7-1/2	(191.0)
1-1/2	(38.1)	12-1/2	(318.0)
1-7/8	(47.6)	15-1/2	(394.0)
2-1/8	(54.0)	17-1/2	(445.0)
d	(d)	30	(762.0)

[a] See 10.5 for a description of the minor dimension of an opening.
[b] Between 3/4 inch and 2-1/8 inches, interpolation is to be used to determine a value between values specified in the table.
[c] Any dimension less than 1 inch applies to a motor only.
[d] More than 2-1/8 inches, but not more than 6 inches (152 mm).

10.2 With regard to a moving part or film-coated wire within the enclosure of a motor as specified in the Exception to 10.1:

a) An opening that has a minor dimension, as described in 10.5, of less than 3/4 inch (19.1 mm) is not prohibited when:

1) In an indirectly accessible motor, an uninsulated live part or a moving part cannot be contacted by the probe illustrated in Figure 10.2;

2) Film-coated wire cannot be contacted by the probe illustrated in Figure 10.3; and

3) In a directly accessible motor, an uninsulated live part or a moving part cannot be contacted by the probe illustrated in Figure 10.4.

b) An opening that has a minor dimension of 3/4 inch or more is acceptable if an uninsulated live part, a moving part, or film-coated wire is spaced from the opening as specified in Table 10.1.

Figure 10.2
Probe for moving parts and uninsulated live parts

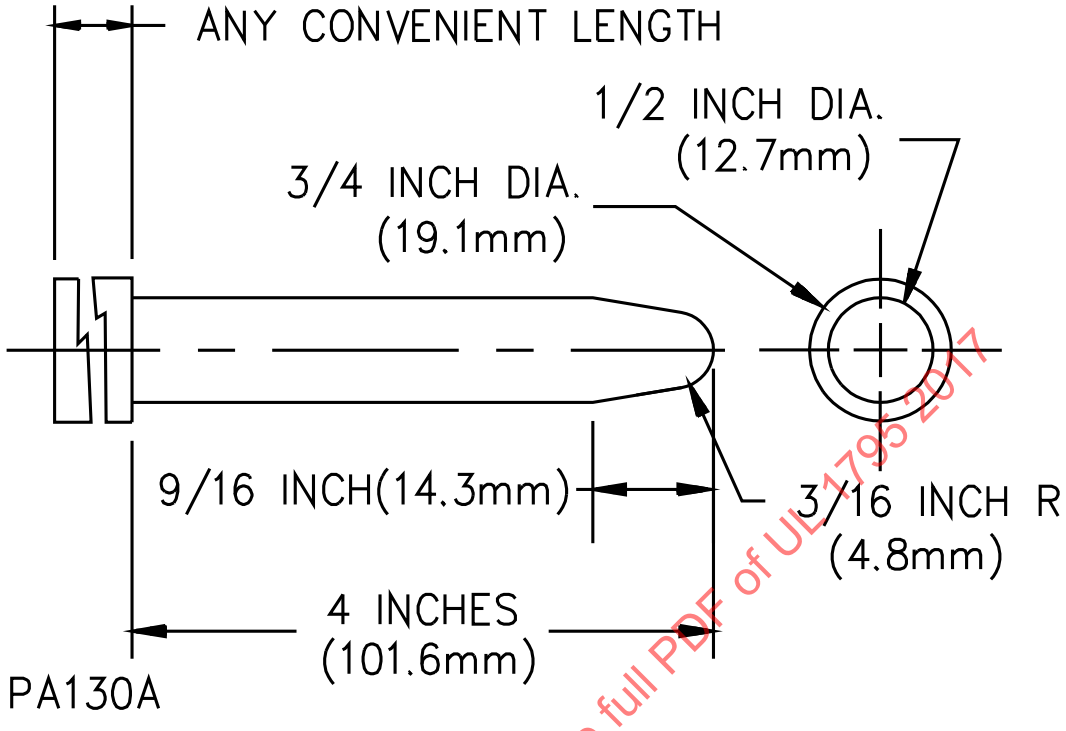


Figure 10.3
Probe for film-coated wire

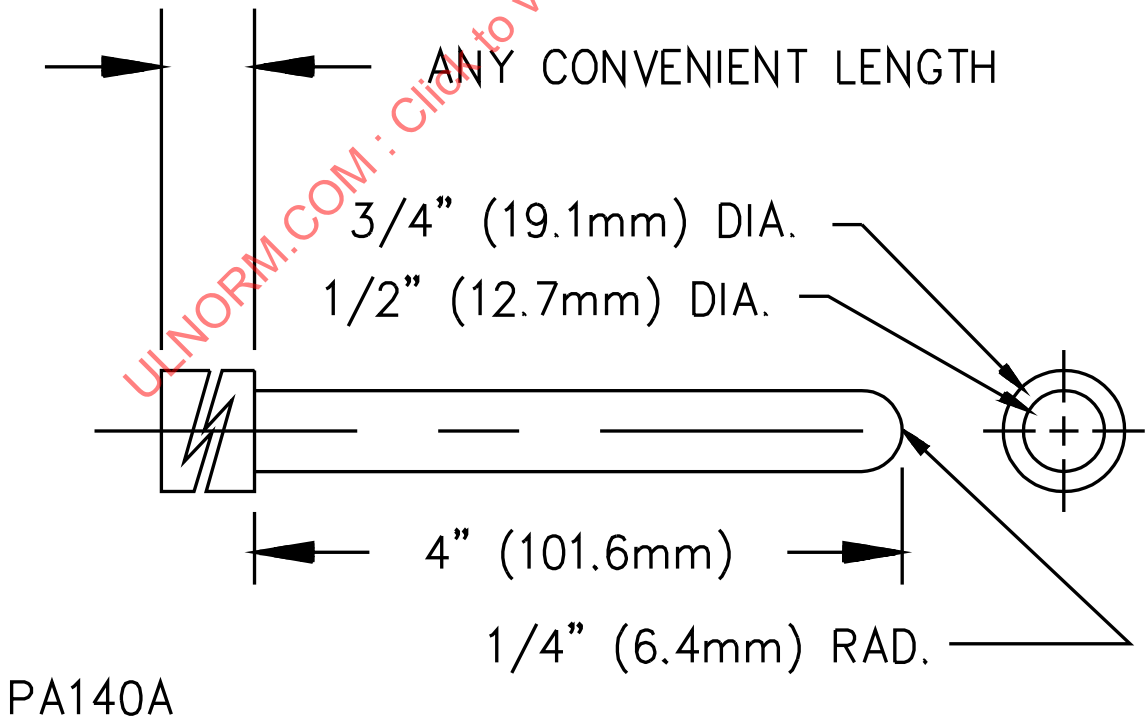
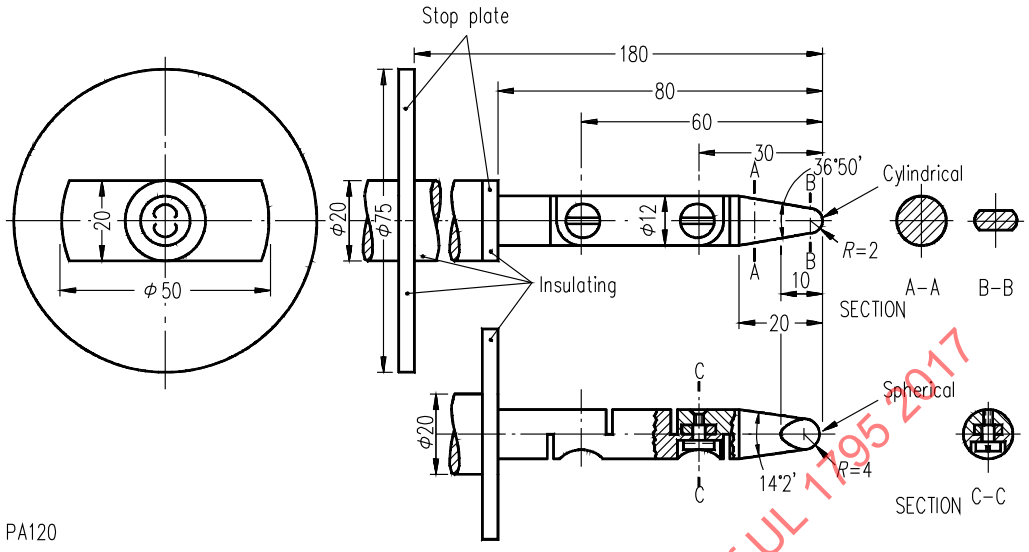


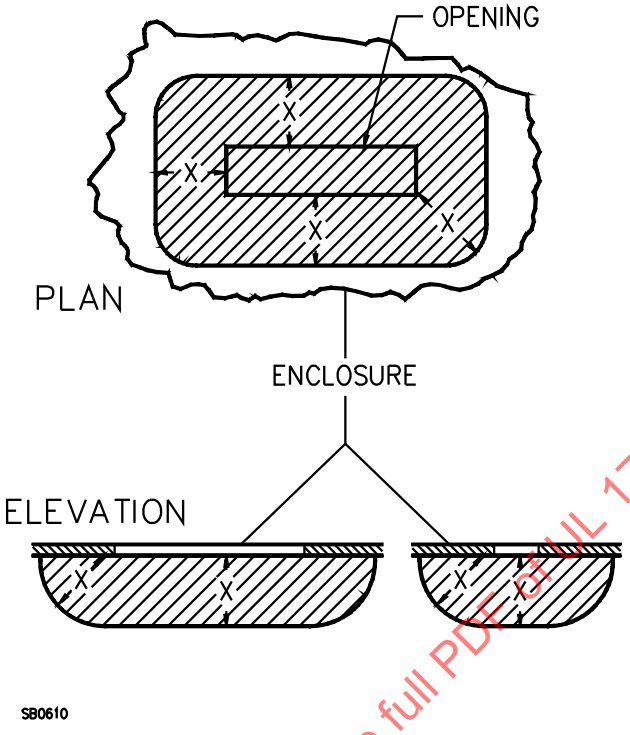
Figure 10.4
Articulate probe



Inches:	5/64	5/32	25/64	15/32	25/32	1-5/64	1-61/64	2-23/64	2-61/64	3-9/64	7-3/32
(mm):	(2)	(4)	(10)	(12)	(20)	(30)	(50)	(60)	(75)	(80)	(180)

10.3 The probes specified in 10.1 and 10.2 and illustrated in Figures 10.1 – 10.4 shall be applied to any depth that the opening illustrated in Figure 10.5 will permit, and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the enclosure. The probes illustrated in Figures 10.1 and 10.4 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

Figure 10.5
Opening in enclosure



10.4 The probes illustrated in Figures 10.1 – 10.4 shall be used as measuring instruments to judge the accessibility provided by an opening, and not as instruments to judge the strength of a material; they shall be applied with the minimum force necessary to determine accessibility.

10.5 With reference to the requirements in 10.1 and 10.2, 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.

10.6 During the examination of a unit to determine whether it complies with the requirements in 10.1 or 10.2, a part of the enclosure that may be opened or removed by the user without using a tool (to attach an accessory, to make an operating adjustment, or for other reasons) is to be opened or removed.

10.7 A directly accessible motor is a motor that may be contacted without opening or removing any part and that is located so as to be accessible to contact. An indirectly accessible motor is a motor that is accessible only by opening or removing a part of the outer enclosure, such as a panel or service door that can be removed without the use of tools, or a motor that is located in such a position or is otherwise guarded or enclosed so that it is unlikely to be contacted.

11 Provisions for Servicing

11.1 A hydromassage bathtub shall incorporate means for servicing internal components after installation as specified in 6.3.

11.2 An enclosure door or cover intended to give the user access to a fuseholder, a switch, or a circuit breaker shall be hinged, captive to the enclosure, and provided with a closing device. The door or cover shall be constructed such that no live part is accessible when the door is closed.

12 Resistance to Corrosion

12.1 An iron or steel part shall be made resistant to corrosion by enameling, galvanizing, plating, or other equivalent means when the corrosion of such a part is capable of resulting in a risk of fire, electric shock, or injury to persons.

Exception: Bearings, laminations, or minor parts of iron or steel, such as washers and screws, are not required to be corrosion resistant.

12.2 Aluminum, stainless steel, and copper or copper alloy with zinc content not in excess of 15 percent may be used without additional resistance to corrosion.

12.3 When, during use, aluminum comes into contact with water in the unit, it shall be an alloy of the 5000 series as given in the Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate, ASTM B209. Cast aluminum shall be one of the alloys shown in Table 12.1 or shall be an alloy that has been found to have equivalent resistance to corrosion.

Table 12.1
Aluminum alloys

Sand-cast	Permanent-mold cast	Die cast	Machined bar and rod stock
G4A	GM70B	G8A	5052
G10A	GS42A	S5C	5056
GM70B	S5A	S12A	5456
GS42A	S5B	S12B	6061
S5A	SG70A	SG100A	6063
S5B	SG70B	GS100B	
SG70A			
ZG61B			

12.4 Metals shall not be used in combinations to cause galvanic action.

12.5 A sheet steel enclosure and other parts of a unit, including hinges and other attachments, shall be made resistant to corrosion as specified in 12.1.

12.6 An enclosure that is entirely within the outer enclosure of a unit and that contains any live part other than a motor shall be made resistant to corrosion as described in 12.7(c)(1) and 12.7(c)(2) with or without the added epoxy, paint coating, or other means described in 12.7 and 12.8.

12.7 Sheet steel shall be made resistant to corrosion by one of the following:

a) Hot-dipped, mill-galvanized sheet steel designated 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.

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 (0.015 mm) on each side, with a minimum thickness of 0.00054 inch (0.014 mm). The thickness of the coating shall be determined by the Metallic Coating Thickness Test, Section 64. An annealed coating shall also comply with 12.8.

c) A coating that complies with (1) or (2) and with one coat of an organic finish of the epoxy or alkyd-resin type paint on each surface applied after forming. The acceptability of the paint may be determined by consideration of its composition or by corrosion tests.

1) Hot-dipped, mill-galvanized sheet steel designated G60 or A60 in ASTM A653/A653M.

2) 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 (0.011 mm) on each surface with a minimum thickness of 0.00034 inch (0.009 mm). An annealed coating shall also comply with 12.8.

d) A cadmium coating not less than 0.0010 inch (0.025 mm) thick on both surfaces. The thickness of the coating shall be determined by the Metallic Coating Thickness Test, Section 64.

e) A cadmium coating not less than 0.00075 inch (0.019 mm) thick on both surfaces with one coat of paint on both surfaces, or not less than 0.00051 inch (0.013 mm) thick on both surfaces with two coats of paint on both surfaces. The paint shall be as described in (c).

f) Other finishes, including paints, special metallic finishes, and combinations of the two may be accepted if comparative tests with galvanized sheet steel (without annealing, wiping, or other surface treatment) complying with (a) indicate that such finishes provide equivalent resistance to corrosion. Among the factors that are to be taken into consideration when judging such finishes are exposure to salt spray, moist carbon dioxide-sulfur dioxide-air mixtures, moist hydrogen sulfide-air mixtures, ultraviolet light, and water. Organic coatings shall comply with the Standard for Organic Coatings for Steel Enclosures for Outdoor Use Electrical Equipment, UL 1332.

12.8 An annealed coating on sheet steel that is bent or similarly formed or extruded, or rolled at edges of holes after annealing shall be additionally painted in the affected areas if the process damages the zinc coating. If flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification, the zinc coating is considered to be damaged. Simple sheared or cut edges and punched holes are not required to be additionally treated.

13 Power Supply Connections

13.1 General

13.1.1 A unit shall have provision for termination of a permanent wiring system in accordance with 13.2.1 – 13.2.18 or shall be provided with a non-detachable power supply cord in accordance with 13.3.1 – 13.3.6.

13.1.2 A unit intended for connection to a grounded power supply conductor and using a lampholder of the Edison screwshell type or a single pole switch or control shall have one terminal or lead intended for connection of the grounded conductor supply circuit. The terminal or lead intended for such use shall be the one connected to screwshells of lampholders and shall not be the one connected to a single pole switch or control.

13.1.3 A terminal for connection of a grounded power supply conductor shall be of, or plated with, metal that is substantially white in color and shall be readily distinguishable from the other terminals; or identification of the terminal for the connection of the grounded conductor shall be clearly shown in some other manner, such as on an attached wiring diagram.

13.1.4 A lead for connection of a grounded power supply conductor shall be finished to show a white or gray color and shall be readily distinguishable from the other leads.

13.1.5 A unit may have provision for a maximum of three supply sources. If the unit is cord-connected, all supply sources shall be through cord connection.

13.2 Permanently connected units

13.2.1 A unit shall be provided with a terminal compartment for the connection of power supply conductors.

Exception: A terminal compartment provided as an integral part of a motor that complies with the requirements for field wiring in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, and is marked "Acceptable for Field Wiring" is considered to comply with the requirements for a terminal compartment specified in 13.2.

Table 13.1
Motor terminal compartments for wire-to-wire connections

Horsepower (kW output)	Minimum dimension,		Minimum usable volume,	
	inches	(mm)	cubic inches	(cm^3)
1 (0.7) or less[a]	2-1/4	(57)	10.5	(172)
1-1/2, 2, and 3 (1.2, 1.5, and 2.2)[a]	2-1/2	(64)	16.8	(275)
5 and 7-1/2 (3.7 and 5.6)	2-7/8	(73)	22.4	(367)
10 and 15 (7.5 and 11.2)	3-1/2	(89)	36.4	(596)

[a] When the terminal compartment is partially or wholly integral with the frame or end shield, the minimum dimension of the cover opening is not specified, and the volume of the terminal compartment shall be not less than:

1) 1.1 cubic inch (18.1 cm^3) per wire-to-wire connection for 1 horsepower or smaller motors.

2) 1.4 cubic inch (22.9 cm^3) per wire-to-wire connection for 1-1/2, 2, and 3 horsepower motors.

13.2.2 A terminal compartment shall be complete and shall enclose all field wiring terminals. No ventilation opening shall be located in the field wiring compartment.

Exception: A small hole provided for drainage is not considered a ventilation opening.

13.2.3 A terminal compartment shall be located so that when conduit connections are made, internal wiring and electrical components shall not be exposed to mechanical abuse and strain. After the unit has been installed as intended, supply connections shall be accessible for inspection without exposing internal wiring and electrical components to mechanical abuse or strain.

13.2.4 A terminal compartment shall be attached to the unit in a manner to reduce the risk of the terminal compartment turning.

13.2.5 Electrical components shall not be mounted on the terminal compartment cover unless the internal wiring is provided with a method of quick disconnection.

13.2.6 Wire-bending space in a terminal compartment shall be as specified in Table 13.2.

Exception: A terminal compartment provided as an integral part of a motor that complies with the requirements for field wiring in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, and is marked "Acceptable for Field Wiring" is considered to comply.

Table 13.2
Minimum wire-bending space

Wire size, AWG	Wire size, (mm^2)	Minimum wire-bending space from terminal to wall, inches	Minimum wire-bending space from terminal to wall, (mm)
14 – 10	(2.1 – 5.3)	Not specified	–
8	(8.4)	1-1/2	(38.1)
6	(13.3)	2	(50.8)
4	(21.2)	3	(76.2)

13.2.7 Sheet metal to which a wiring system is to be connected in the field shall be not less than 0.032 inch (0.81 mm) thick steel if uncoated, not less than 0.034 inch (0.86 mm) thick steel if galvanized, or not less than 0.045 inch (1.14 mm) thick if nonferrous.

13.2.8 A knockout for connection of a field wiring system to a field wiring compartment shall accommodate conduit of the trade size specified in Table 13.3.

Table 13.3
Trade size of conduit in inches

Wire size, AWG	Wire size, (mm^2)	Number of wires				
		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.

13.2.9 A wiring compartment shall be free of any sharp edge, burr, fin, or moving part that can damage the conductor insulation.

13.2.10 The threads of a threaded conduit entry shall comply with Pipe Threads, General Purpose (Inch), ASME B1.20.1; Threaded Conduit Entries, CSA C22.2 No. 0.5, or Unified Screw Threads – Specifications, ANCE NMX-H-146-SCFI.

13.2.11 If power supply connections are made in a panelboard provided with branch circuit overcurrent protection, the wiring space, bending space, and provisions for field wiring shall comply with the requirements in the Standard for Panelboards, UL 67.

13.2.12 A terminal box shall be provided with wiring terminals or leads for the connection of power supply conductors having an ampacity no less than the current rating of the product.

13.2.13 The free length of a lead inside the terminal compartment shall be 6 inches (152 mm) or more if the lead is intended for field connection to an external circuit. The leads provided for connection to the branch-circuit supply shall have an ampacity rating not less than that of a conductor of the next smaller size than that acceptable for the rating of the product.

13.2.14 A 14 AWG (2.1 mm^2) wire is the smallest conductor that may be used for branch circuit wiring, and thus is the smallest conductor that may be anticipated for connection of a power supply conductor.

13.2.15 If a wire binding screw or a pressure wire connector is used as a terminating device for aluminum wire, it shall be rated for use with aluminum under the conditions involved (for example, temperature, heating, and cycling).

13.2.16 A field-wiring terminal shall be rated for use with copper conductors only, aluminum conductors only, or with copper or aluminum conductors, and shall be marked as indicated in 71.11.

13.2.17 A wiring terminal shall be provided with a soldering lug or with a pressure wire connector, firmly bolted or held by a screw.

Exception: A wire-binding screw is not prohibited from being used at a terminal intended to accommodate a 10 AWG (5.3 mm^2) or smaller conductor when upturned lugs or the equivalent are provided to hold the wire in position.

13.2.18 A wire-binding screw shall thread into metal and shall not be smaller than No. 10 (4.8 mm diameter).

Exception: A No. 8 (4.22 mm diameter) screw is not prohibited from being used at a terminal intended only for the connection of a 14 AWG (2.1 mm^2) conductor.

13.2.19 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.030 inch (0.76 mm) thick. There shall be no fewer than two full threads in the metal, which is not prohibited from being extruded when necessary to provide the threads.

13.3 Cord- and plug-connected units

13.3.1 A unit may be provided with a non-detachable power supply cord, Type SJ or equivalent, not longer than 3 feet (0.91 m), directly connected to the unit and terminated in an attachment plug. The length of the cord is measured from the point at which the cord emerges from the unit to the face of the attachment plug. The rating of the plug and the ampacity of the cord shall be not less than 100 percent of the rating of the unit.

13.3.2 Strain relief shall be provided so that mechanical stress on a power supply cord will not be transmitted to terminals, splices, or interior wiring.

13.3.3 A strain-relief device shall be subjected to the Strain Relief Test, Section 65.

13.3.4 Where a flexible cord passes through an opening in a wall, barrier, or enclosing case, there shall be an acceptable bushing or the equivalent that is reliably secured in place, and has a smooth surface against which the cord may bear.

13.3.5 A cord opening with a smooth surface through wood, porcelain, phenolic composition, or other acceptable nonconductive material shall be considered to be the equivalent of a bushing.

13.3.6 Insulating material in an insulated metal grommet used in lieu of an insulating bushing shall be not less than 1/32 inch (0.8 mm) thick and shall completely fill the space between the grommet and the metal in which it is mounted.

13.3.7 Components provided with cords for supply connection shall have fastening means and mechanical connection that are specifically designed to facilitate removal for maintenance and repair.

13.3.8 The flexible cord specified in 13.3.1 shall comply with the Standard for Cord Sets and Power-Supply Cords, UL 817, and the Standard for Flexible Cords and Cables, UL 62. Attachment plugs shall comply with the Standard for Attachment Plugs and Receptacles, UL 498.

14 Live Parts

14.1 A current-carrying part shall be of stainless steel, silver, copper, a copper alloy, or equivalent material.

14.2 Plated iron or steel may be used for a current-carrying part whose temperature during intended operation is more than 100°C (212°F).

15 Internal Wiring

15.1 General

15.1.1 The wiring between components shall be in conduit, cable, or flexible cord. When flexible cord is used, it shall:

a) Be Type SJ, SJT, or the equivalent;

b) Be routed so as to reduce the risk of mechanical abuse; and

c) Follow the contour of the frame.

Exception: The wiring method for Class 2 circuitry and limited energy circuitry used in other than safety circuits, is not specified except that spacings between circuits shall be maintained as outlined in 22.4.1.

15.1.2 Cords used for interconnection between equipment enclosures shall comply with the Standard for Cord Sets and Power-Supply Cords, UL 817, and the Standard for Flexible Cords and Cables, UL 62.

15.1.3 Strain relief complying with 13.3.2 – 13.3.6 shall be provided where a cord enters a component enclosure.

Exception: Strain relief is not required when the cord is:

a) Mounted to prevent movement that transmits strain to a connection; and

b) Located where it is not likely to be moved during installation or user servicing.

15.1.4 Internal wiring shall consist of wires that have been investigated with regard to:

a) Temperature and voltage;

b) Exposure to oil, grease, or other substances likely to have an adverse effect on the insulation;

c) Exposure to moisture; and

d) Other conditions of service (such as vibration and mechanical abuse) to which the wiring is likely to be subjected.

15.1.5 Internal wiring shall comply with the Standard for Fixture Wire, UL 66; the Standard for Thermoset-Insulated Wires and Cables, UL 44; the Standard for Thermoplastic Insulated Wires and Cables, UL 83; or the Standard for Appliance Wiring Material, UL 758.

15.1.6 When internal wiring is capable of being subjected to mechanical damage, the wiring shall be in armored cable, conduit, electrical metallic tubing, metal raceway, or the equivalent.

15.1.7 Internal wiring shall be located 1-1/2 inches (38.1 mm) above the mounting surface to reduce the risk of contact with any sharp edge, burr, fin, or moving part that may abrade the insulation or damage the wiring.

15.2 Splices and connections

15.2.1 Quick-connect terminals shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310.

15.2.2 A splice or connection shall be made mechanically secure.

15.2.3 Except for limited-energy circuits, all splices and terminal connections shall not be accessible.

15.2.4 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 loose. Upturned ends on the tang of the lug or a retaining barrier are not prohibited from being used to hold the lug in place.

15.2.5 Aluminum conductors used as internal wiring shall be terminated by a method that is acceptable for the combination of metals involved.

15.2.6 A hole in a sheet-metal wall through which insulated wires pass shall be provided with a smooth, rounded bushing or shall have a smooth, well-rounded surface upon which the wires may bear to reduce the risk of damage to the insulation.

15.2.7 A wire-binding screw or nut shall be provided with a lockwasher under the head of the screw, or under the nut, to keep the screw or nut from becoming loosened due to vibration when such loosening permits the shifting of parts, thereby reducing spacings, or otherwise results in a risk of fire, electric shock, or injury to persons.

15.2.8 Stranded wire shall not have loose strands contacting other live parts not always at the same polarity, and shall not contact dead-metal parts. This is to be accomplished by use of a pressure terminal connector, soldering lug, crimped eyelet, soldering all strands of the wire together, or the equivalent.

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

15.2.10 Two layers of thermoplastic insulating tape or one layer of friction tape on top of one layer of rubber insulation tape is acceptable on a splice. In determining whether splice insulation consisting of coated fabric, thermoplastic, or other type of tubing is acceptable, consideration is to be given to such factors as dielectric properties and heat-resistant and moisture-resistant characteristics. Thermoplastic tape wrapped over a sharp edge is not to be used.

16 Separation of Circuits

16.1 Unless the low-voltage wiring is provided with insulation rated for the highest voltage involved, conductors of line- and low-voltage circuits (internal wiring, including wires in a terminal box or compartment) shall be separated by barriers or shall be segregated. Wiring in circuits of any voltage shall be separated or segregated from uninsulated live parts connected to circuits of a different voltage.

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

16.3 Field-installed conductors of any circuit shall be segregated by barriers from:

a) Field-installed conductors connected to any other circuit;

b) Factory-installed conductors connected to another circuit unless the field-connected circuit has the highest voltage rating and the factory-installed conductors are insulated for the maximum voltage of the field-connected circuit; and

c) Uninsulated live parts of any other circuit.

16.4 With regard to 16.3(a), a removable barrier or one having openings for the passage of conductors is not prohibited from being used when instructions for the use of the barrier are provided as a permanent part of the unit. When complete instructions, in conjunction with a wiring diagram, will provide for the separation of the line voltage and low voltage circuits, the barrier is not prohibited, upon investigation, from being omitted.

16.5 Separate compartments for field connection to circuits of line and low voltage shall be provided.

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

16.7 A metal barrier shall have a thickness at least as great as the required thickness of the enclosure metal. A barrier of insulating material shall be no less than 0.028 inch (0.71 mm) thick and shall be of greater thickness if its deformation may be readily accomplished so as to defeat its purpose.

17 Grounding

17.1 Each permanently connected unit shall be provided with a separate terminal or lead within the terminal compartment specified in 13.2.1 intended solely for the connection of the equipment grounding conductor.

17.2 Double-insulated units shall not have provision to terminate an equipment grounding conductor.

17.3 Each cord-connected unit shall have provisions for grounding in accordance with 17.6 and 17.7.

17.4 Double-insulated units shall not be grounded.

17.5 Double-insulated units shall not be provided with grounding type attachment plugs.

17.6 The surface of an insulated grounding conductor of a flexible cord shall be green with or without one or more yellow stripes and no other lead shall be so identified.

17.7 The grounding conductor of a power-supply cord shall be attached to the grounding blade of an attachment plug and shall be connected within the frame or enclosure by means of a screw not likely to be removed during ordinary servicing not involving the power-supply cord.

17.8 A terminal for connection of an equipment grounding conductor shall be located so that removal during servicing is unlikely, and sized in accordance with Table 17.1.

Table 17.1
Minimum size of equipment grounding conductor

Rating of branch circuit protective device, amperes	Copper wire, AWG	Aluminum or copper-clad aluminum, AWG
15	14	12
20	12	10
30	10	8
40	10	8
60	10	8
100	8	6

17.9 A wire binding screw may be used to terminate a conductor that is no larger than 10 AWG (5.3 mm^2). The screw shall have a green-colored head that is hexagonal, slotted, or both.

17.10 A pressure wire connector intended for connection of a field-installed equipment grounding conductor shall be plainly identified, such as being marked ″G,″ ″GR,″ ″GRD,″ ″Ground,″ ″Grounding,″ or the like. The IEC Publication 417, Symbol 5019 ⏚ is not prohibited from being used; and if used alone, the symbol shall be defined in the installation instructions provided with the equipment.

17.11 A lead intended for connection to an equipment grounding conductor shall be of the size specified in Table 17.1 and shall have a free length of not less than 6 inches (152 mm).

17.12 The surface of an insulated lead intended solely to connect an equipment grounding conductor shall be green with or without one or more yellow stripes. No other lead that is located in a field wiring compartment and that is visible to the installer shall be so identified.

17.13 The metal enclosure of each electrical component, current collector, if provided, and all other metal that could become energized in the event of a fault shall be bonded to the equipment grounding means. This may be accomplished by metal-to-metal mounting on a common metal frame or by individual grounding conductors. Grounding conductors, if used, shall be not smaller than the supply conductors and shall be routed close to the contour of the equipment frame and terminated using suitable pressure wire connectors.

Exception: Metal enclosures that contain only Class 2 circuits are not required to be bonded to the equipment grounding means.

17.14 Sheet-metal screws shall not be used for the termination of equipment grounding or bonding conductors.

17.15 The core of a transformer used to energize a circuit that is accessible to the tub occupant, or in contact with circulating water, shall not be bonded to the equipment grounding means.

Exception: This requirement does not apply to concentrically wound transformers with primary and secondary separated by a grounded copper shield at least 0.005 inch (0.127 mm) thick.

18 Equipotential Bonding

18.1 All grounded metal in contact with the tub water shall be bonded together. This shall be accomplished by individual bonding conductors. Bonding conductors shall be:

a) Solid copper;

b) Not smaller than 8 AWG (8.4 mm^2); and

c) Routed close to the contour of the equipment frame and terminated using suitable pressure wire connectors.

In addition, bonding conductors may be insulated, covered, or bare.

18.2 In addition to the bonding required in 18.1, each unit shall be provided with at least one unused external pressure wire connector to accommodate a 8 AWG (8.4 mm^2) solid copper bonding conductor. On units intended for permanent connection to the supply, the bonding wire connector shall be located on the terminal compartment specified in 13.2.1 or on the pump motor. On units intended for cord connection, the bonding wire connection shall be on the pump. Units with multiple supplies, such as heater and pump circuits, shall have a bonding connection for each circuit.

Exception: This requirement does not apply to hydromassage bathtubs consisting of components that are all double-insulated.

18.3 Sheet-metal screws shall not be used for the termination of bonding conductors.

19 Circuits

19.1 General

19.1.1 Circuits and controls shall comply with the requirements of this standard and those in either Supplement SA, SB or SC.

19.1.2 All circuits shall be evaluated to determine that single-mode component faults will not result in a risk of fire, electric shock, casualty hazards or loss of a Safety Critical Function.

19.1.3 When safety related circuits are investigated, consideration shall be given to the need for additional testing, depending on the circuit construction and the intended function.

Exception: A reliability investigation may not be required if each critical circuit component is protected by a redundant component, and each critical power-limiting resistor complies with the requirements in the Standard for Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances, UL 1412.

19.2 Secondary circuits

19.2.1 A conductive part of a secondary circuit, other than a limited-energy circuit, is to be evaluated as a live part for the accessibility requirements specified in Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts, Section 10, and the spacing requirements specified in Spacings, Section 22.

19.3 Circuits accessible to a bathtub occupant

19.3.1 A circuit that is accessible to the occupant of a hydromassage bathtub, as defined in 4.3, or that is in contact with the circulating water shall:

a) Be permanently routed and protected to reduce the risk of mechanical damage;

b) Possess two discrete insulating systems or be permanently spaced from live parts and all other circuits as specified in Spacings, Section 22; and

c) Not present a risk of electric shock as defined in 4.20.

19.4 Circuits that perform Safety Critical Functions

19.4.1 Any function involved in the control, protection, and monitoring of safety-related attributes of a hydromassage bathtub 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. See Table 19.1 for the most common Safety Critical Functions anticipated by this standard.

Table 19.1
Safety Critical Functions

Function [a]	Hazard	Location of parameters and tests
Motor running overload protection	Risk of fire or electric shock	Section 30
Motor locked rotor protection	Risk of fire or electric shock	Section 30
Motor short circuit protection	Risk of fire or electric shock	Section 30
Temperature regulating control	Hyperthermia	Section 40
Temperature limiting control	Scalding	Section 41.2
Water-Flow Controls (dry-fire protection)	Risk of fire, electric shock, or scalding	Section 41.3
[a] Functions specified in the table represent the common safety critical circuit functions of hydromassage bathtubs. It is not intended to represent all possible safety critical functions. Any function involved in the control, protection, and monitoring of safety-related attributes of a hydromassage bathtub 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.		

19.4.2 The on-off function of the overall hydromassage bathtub would be considered a Safety Critical Function only if a mandatory off period is necessary for the unit to comply with the Temperature Test.

19.4.3 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.

19.4.4 A component, such as a switch or a relay, or an electronic circuit that is used to perform a safety function, shall not be used to perform any other function.

Exception: A component or an electronic circuit is not prohibited from being used to perform functions in addition to the primary safety function when the results of an investigation indicate that the reliability of components in such multiple functions is suitable for the application.

20 Insulation

20.1 Electrical insulation

20.1.1 Uninsulated live parts shall be mounted on porcelain, phenolic, or polymeric material in accordance with 20.1.4.

20.1.2 Vulcanized fiber is not prohibited from being used for an insulating bushing, a washer, a separator, or a barrier, but not as the sole support for an uninsulated live part when shrinkage, moisture, or warpage introduces a risk of injury to persons.

20.1.3 A molded part shall have sufficient mechanical strength and rigidity to withstand the stresses of intended service.

20.1.4 Polymeric materials used as electrical insulation shall comply with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. When molded by an outside source, material identification shall be provided according to the Standard for Polymeric Materials – Fabricated Parts, UL 746D.

20.2 Thermal insulation

20.2.1 An insulating material shall be secured in place by more than friction between surfaces.

20.2.2 Thermal insulation, when provided, shall be of such material and located, mounted, and supported so that it is not adversely affected by the conditions of either intended operation of the unit or abnormal operation of the unit.

20.2.3 A polymeric material used as thermal insulation shall be rated minimum HB in accordance with the requirements in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

20.2.4 Thermal insulation shall be rated for the temperature to which it is exposed when subjected to the Temperature Test, Section 51.

21 Printed-Wiring Boards

21.1 A printed-wiring board shall comply with the requirements in the Standard for Printed-Wiring Boards, UL 796, and shall have a minimum rating of V-2 in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception: Printed-wiring boards containing only Class 2 circuitry are not required to comply with this requirement.

21.2 Printed-wiring boards used in primary, secondary, and safety circuits shall be rated for direct support applications in accordance with the Standard for Printed-Wiring Boards, UL 796.

Exception: Printed-wiring boards containing only Class 2 circuitry are not required to comply with this requirement.

21.3 Components shall be secured and mounted to a printed-wiring assembly such that any force that may be exerted on the components or board during assembly, shipping, or handling of the equipment, or during use or servicing will not displace the components or deflect the board so as to produce a risk of fire or electric shock.

22 Spacings

22.1 General

22.1.1 All uninsulated live parts connected to different circuits shall be spaced as though the parts were of opposite polarity and shall be evaluated on the basis of the highest voltage involved.

22.1.2 Spacing requirements do not apply to the internal spacings of a component. The acceptability of a component shall be determined in accordance with 7.1.1.

22.2 Class 2 circuits

22.2.1 The spacings in a Class 2 circuit are to be investigated on the basis of the Dielectric Voltage-Withstand Test, Section 52. Spacings between a Class 2 circuit and another circuit shall comply with 22.4.1.

22.3 Field-wiring terminals

22.3.1 The spacing between field-wiring terminals of opposite polarity, and a wiring terminal and any uninsulated metal part not at the same polarity shall be at least 1/4 inch (6.4 mm).

22.4 Other than field-wiring terminals

22.4.1 Spacings other than at a field-wiring terminal shall be 1/8 inch (3.2 mm) for live parts and 1/16 inch (1.6 mm) for grounded or dead-metal parts when measured between parts of opposite polarity, accessible metal, and the enclosure.

22.5 Safety circuits

22.5.1 Spacings safety circuitry and all other circuitry or grounded metal shall be not less than the spacing specified in 22.4.1.

22.6 Printed-wiring boards

22.6.1 Spacings on printed-wiring boards shall comply with the requirements specified in 19.1.3.

22.6.2 Spacings within safety circuitry shall be not less than 1/64 inch (0.4 mm) and spacings between safety circuits and other circuits shall be not less than 1/32 inch (0.8 mm).

22.6.3 Spacings within circuits accessible to the bathtub occupant or in contact with the water and between these circuits and other circuits shall be not less than 1/16 inch (1.6 mm) and not less than 1/32 inch (0.8 mm) if provided with a conformal coating. These spacings shall apply to those parts of a circuit from any point accessible to the occupant of the bathtub or in contact with the water up to a reliable means of isolation, such as a transformer or optical isolator. The isolating means shall provide minimum 1500 VAC isolation from input to output.

Exception No. 1: A conformal coating is not required to be provided when the printed-wiring board is used in a controlled environment.

Exception No. 2: A protective coating is not prohibited from being used in lieu of a conformal coating when the protective coating, when tested on the printed-wiring board, complies with the requirements specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

22.7 Spacings within motors

22.7.1 The spacings within a motor shall comply with the spacings requirements specified in the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

23 Clearance and Creepage Distances

23.1 As an alternative approach to the spacing requirements specified in Spacings, Section 22, and other than as noted in 23.2, clearances and creepage distances may be evaluated in accordance with the requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, as described in 23.3.

23.2 The clearance and creepage distance at field wiring terminals shall be in accordance with the requirements in Spacings, Section 22.

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

a) For evaluating clearances:

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

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

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

24 Ground-Fault Circuit-Interrupters

24.1 Each unit shall be marked to require connection to a supply circuit that is protected by a ground-fault circuit-interrupter in accordance with 71.7 and shall be provided with the instructions in 79.1.

25 Electric Heaters

25.1 Electric heaters, if provided, shall comply with the Standard for Sheathed Heating Elements, UL 1030.

26 Hydromassage Bathtubs Configured for Field-Installed Heaters

26.1 The requirements in 26.2 – 26.6 are to be used in conjunction with Sections 6 – 44. The requirements in 26.2 – 26.6 supersede corresponding requirements in other sections of this standard.

26.2 A hydromassage bathtub configured for a field-installed heater shall be constructed so that, when the heater is installed, the combination does not create a risk of fire, electric shock, and/or injury to persons.

26.3 A hydromassage bathtub configured for a field-installed heater shall possess the necessary installation fitting(s) before the unit leaves the factory.

26.4 The installation of a field-installed heater shall be restricted to an arrangement that is accomplished mechanically by means of common household tools such as pliers or screwdrivers.

Exception: For installation where special tools are provided with the heater, the special tools shall be considered no more difficult to use than the common household tools specified in 26.4.

26.5 As part of the investigation of the hydromassage bathtub, the heater intended for field installation shall be trial-installed to determine that installation is feasible and that the instructions are detailed and correct.

26.6 A hydromassage bathtub configured for a heater intended for field installation shall be marked in accordance with Hydromassage Bathtubs Configured for Field-Installed Heaters, Section 73.

26.7 A hydromassage bathtub configured for a field-installed heater shall be provided with an unused external pressure wire connector to accommodate an 8 AWG (8.4 mm^2) solid copper bonding conductor from the heater.

Exception: An unused pressure wire connector is not required to be provided if a connector suitable to terminate two 8 AWG solid copper conductors is provided with the field-installed heater. The installation instructions provided with the heater shall detail how to replace the factory-installed bonding connector of the hydromassage bathtub.

27 Field-Installed Heaters

27.1 The requirements in 27.2 and 27.3 are to be used in conjunction with Sections 6 – 44. The requirements in 27.2 and 27.3 supersede corresponding requirements in other sections of this standard.

27.2 The supply connection of a heater intended for field installation shall be accomplished with either:

a) A non-detachable power supply cord in accordance with 13.3.1 – 13.3.6; or

b) A cord and plug intended for connection to a controller provided in the bathtub.

27.3 A heater intended for field installation shall be provided with a grounded metal enclosure that surrounds the heating element for the entire length that the heating element is exposed to water.

27.4 A heater intended for field installation shall be provided with an unused external pressure wire connector to accommodate an 8 AWG (8.4 mm^2) solid copper bonding conductor.

27.5 A heater intended for field installation shall be provided with a length of 8 AWG (8.4 mm^2) solid copper conductor to connect to the bathtub bonding terminal specified in 26.7.

27.6 A heater intended for field installation shall be provided with the required temperature-regulating, temperature-limiting, and dry-fire controls in accordance with Sections 28, 40, and 41.

27.7 An heater intended for field installation shall be marked in accordance with Field-Installed Heaters, Section 74.

28 Heater Protection

28.1 A unit with a heater shall be provided with protection to reduce the risk of damage to the heater or adjacent parts when there is no water flow through the heater. The unit shall comply with the low water, interrupted power, water flow interruption abnormal operation, and dry-fire control operation tests described in this standard.

28.2 A water-sensing device, when used as the dry-fire protection specified in 28.1, shall be installed such that the risk of contamination due to hair, dirt, debris, or calcium deposits is minimized.

28.3 A control device or circuit used to comply with the requirements in 28.1 shall have an electrical rating that corresponds to the electrical load controlled and shall be capable of interrupting the load for 100,000 cycles of operation.

28.4 Controls provided to comply with 28.1 shall comply with the requirements specified in Supplement SA, SB or SC.

29 Motors

29.1 An electric motor shall comply with the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, except as noted below:

a) The Current and Horsepower Relation, Cord-Connected Motors, Factory Wiring Terminals and Leads and Non-Metallic Functional Parts sections of UL 1004-1 are not applicable.

b) See 8.1 of UL 1795 for the applicability of the Frame and Enclosure (nonmetallic) requirements of UL 1004-1.

c) Metal enclosure requirements of UL 1004-1 are superseded by the requirements of Section 8 of UL 1795.

d) Grounding requirements of UL 1004-1 are superseded by the requirements of Section 17 of UL 1795.

e) The Ventilation Opening requirements of UL 1004-1 are only applicable where the openings are on surfaces considered to be the appliance enclosure (see Section 8 of UL 1795).

f) The Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts requirements of UL 1004-1 is superseded by Section 10 of UL 1795.

g) The Protection Against Corrosion requirements of UL 1004-1 are superseded by Section 12 of UL 1795.

h) The available fault current ratings for motor start and running capacitors specified in UL 1004-1 are not applicable to cord and plug connected pumps.

i) The Switches section of UL 1004-1 is not applicable to centrifugal starting switches.

j) With the exception of the Resilient Mounting and Electrolytic Capacitor Tests, the performance tests of UL 1004-1 are not applicable.

k) The marking requirements of UL 1004-1 are not applicable except for Manufacturer's name or identification; Rated voltage; Rated frequency, If greater than 1, number of phases; and a multi-speed motor, other than a shaded-pole or a permanent-split-capacitor motor, shall be marked with the amperes and horsepower at each speed.

29.2 Double-insulated pumps and blowers shall comply with requirements specified in the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097.

29.3 On a double-insulated pump, a noncurrent-carrying part that either serves to enclose any live part such as the enclosure of a motor, or is likely to become energized in the event of a fault, shall be insulated or spaced away from accessible noncurrent-carrying metal of the pump and from the water being pumped.

30 Motor Overload Protection

30.1 A unit employing a motor shall incorporate thermal or overcurrent protection complying with (a), (b), (c), (d), (e), or (f) below:

a) Thermal or overcurrent protection that complies with both the running overcurrent and locked rotor protection requirements in the Standard for Thermally Protected Motors, UL 1004-3;

b) Electronic protection that complies with the requirements of the Standard for Electronically Protected Motors, UL 1004-7;

c) Electronic overcurrent protection provided as part of a motor-drive complying with the Standard for Power Conversion Equipment, UL 508C. The combination of the motor and the motor drive shall comply with the running overcurrent and locked rotor protection requirements specified in the Standard for Electronically Protected Motors, UL 1004-7;

d) Electronic protection complying with Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the tests of UL 1004-3;

e) Electronic circuits complying with Supplement SA and the tests of UL 1004-3; or

f) Impedance protection complying with the Standard for Impedance Protected Motors, UL 1004-2.

Exception: The motor of an air blower that complies with the requirements for locked rotor protection is not required to be provided with running overload protection.

30.2 A thermal or overcurrent protective device shall not open the circuit during the Temperature Test, Section 51.

30.3 Fuses used for motor-running overcurrent protection shall be located in each ungrounded conductor.

31 Air Blowers

31.1 If the blower is not physically located above the highest possible level of tub water, the blower system shall be provided with two independent levels of protection to prevent water backflow from contacting live parts. Such protection may include an air loop, a check valve, or any construction that, when evaluated, can provide the necessary degree of protection.

31.2 A check valve, when provided to reduce the risk of water backflow into the blower, shall close when the blower output air pressure falls below that water pressure represented by the maximum head of water that the valve may be subjected to under any conditions of filling. The valve shall not leak when subjected to the reverse hydrostatic pressure test described in 63.2.1 over a range of zero to twice that of the maximum water pressure.

32 Overload Protection

32.1 A protective device whose functioning requires resetting or replacement shall be in an accessible location.

Exception: The protective device is not required to be accessible when:

a) The unit, with the protective device shunted out of the circuit, complies with all applicable requirements in this standard; and

b) The presence of the protective device would ordinarily be unknown to the user of the unit because of the location of the device and the omission of reference to the device in the operating instructions and circuit diagrams.

32.2 A circuit breaker used in a 120/240-volt, single-phase, three-wire circuit shall be a two-pole, common-trip type.

32.3 When a circuit breaker is used in a vertical orientation, the up position of the handle shall be the on position.

32.4 For units rated more than 20 amperes, overcurrent protection of not more than 20 amperes shall be provided by a circuit breaker or fuse for each power transformer and each motor circuit.

32.5 A unit rated more than 20 amperes shall incorporate overcurrent protection rated at not more than 20 amperes for each lighting circuit and for the primary of each transformer other than a power transformer.

32.6 The overcurrent protection specified in 32.4 and 32.14 shall be of a type acceptable for branch circuit protection.

Exception: Overcurrent protection is not required if it can be determined that equivalent protection can be provided by the branch circuit protective device.

32.7 A thermal- or overcurrent-protective device shall not open the circuit during intended use of the unit.

32.8 The functioning of an overcurrent-protective device provided as part of a unit, whether required or not, shall not result in a risk of fire, electric shock, or injury to persons.

32.9 An interchangeable fuse mounted in a fuseholder and a fuse that is accessible without the use of a tool shall be mounted or guarded so that no current-carrying part will be exposed to unintentional contact.

32.10 A cartridge fuse assembly shall be mounted so that turning of the assembly will not result in reduced electrical spacings.

32.11 The screwshell of a plug fuseholder and the accessible contact of an extractor fuseholder shall be connected toward the load.

32.12 An overcurrent- or thermal-protective device shall have a current and voltage rating not less than the load it controls.

32.13 If the current rating of a unit is more than 40 amperes, and there are subdivided circuits within the unit supplying two or more power-consuming components (such as motors, motor-control circuits, and electric heating elements) connected in parallel across any pair of main-supply terminals or leads, overcurrent protection shall be provided as a part of the unit for the wiring of each subdivided circuit.

Exception: Additional overcurrent protection is not required for each separate:

a) Motor or heating element circuit supplied by insulated conductors having an ampacity at least one-third that of the protective device in the branch circuit to which the unit will be connected.

b) Motor control circuit supplied by insulated conductors having ampacities at least one-fifth that of the protective device in the branch circuit to which the unit will be connected.

32.14 A heater rated more than 48 amperes shall have the heating elements on subdivided circuits. Each circuit shall not exceed a rating of 48 amperes and shall be protected at not more than 60 amperes by an overcurrent protective device that is an integral part of the unit.

32.15 Fuseholders shall either comply with the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1 in conjunction with any of the associated Part 2 standards listed below, as applicable for the type of fuse:

a) The Standard for Fuseholders – Part 4: Class CC, UL 4248-4;

b) The Standard for Fuseholders – Part 5: Class G, UL 4248-5;

c) The Standard for Fuseholders – Part 6: Class H, UL 4248-6;

d) The Standard for Fuseholders – Part 8: Class J, UL 4248-8;

e) The Standard for Fuseholders – Part 9: Class K, UL 4248-9;

f) The Standard for Fuseholders – Part 11: Type C (Edison Base) and Type S Plug Fuse, UL 4248-11;

g) The Standard for Fuseholders – Part 12: Class R, UL 4248-12; or

h) The Standard for Fuseholders – Part 15: Class T, UL 4248-15.

32.16 Fuses specified in 32.4 – 32.6 shall comply with the Standard for Low-Voltage Fuses – Part 1: General Requirements, UL 248-1, and any of the associated Part 2 standards listed below, as applicable for the type of fuse:

a) The Standard for Low-Voltage Fuses – Part 2: Class C Fuses, UL 248-2;

b) The Standard for Low-Voltage Fuses – Part 3: Class CA and CB Fuses, UL 248-3;

c) The Standard for Low-Voltage Fuses – Part 4: Class CC Fuses, UL 248-4;

d) The Standard for Low-Voltage Fuses – Part 5: Class G Fuses, UL 248-5;

e) The Standard for Low-Voltage Fuses – Part 6: Class H Non-Renewable Fuses, UL 248-6;

f) The Standard for Low-Voltage Fuses – Part 7: Class H Renewable Fuses, UL 248-7;

g) The Standard for Low-Voltage Fuses – Part 8: Class J Fuses, UL 248-8;

h) The Standard for Low-Voltage Fuses – Part 9: Class K Fuses, UL 248-9;

i) The Standard for Low-Voltage Fuses – Part 10: Class L Fuses, UL 248-10;

j) The Standard for Low-Voltage Fuses – Part 11: Plug Fuses, UL 248-11;

k) The Standard for Low-Voltage Fuses – Part 12: Class R Fuses, UL 248-12; or

l) The Standard for Low-Voltage Fuses – Part 15: Class T Fuses, UL 248-15.

32.17 Circuit breaker type overcurrent protections specified in 32.4 shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

33 Leakage Current Collectors

33.1 When a hydromassage bathtub contains an electric water heater that is not provided with a grounded metal enclosure that surrounds the heating element for the entire length that the heating element is exposed to the water, a leakage current collector shall be provided in the water circulating system on the suction side of the heater and on the outlet of the heater so that all water entering and leaving the heater shall flow through the two current collectors. Each collector shall be bonded to the equipment grounding conductor using a bonding conductor no smaller in cross section than the heater supply conductors.

Exception: Other construction features or protective devices are not prohibited from being used when they are:

a) Equivalent to the leakage current collectors; and

b) In compliance with the Test for Leakage Current After Heating Element Failure, Section 57.

The grounded metal sheath of a heating element is not to be considered a current collector.

33.2 A leakage current collector shall be of galvanized or equivalent corrosion resistant metal and shall have a minimum length of five times its inside diameter. If copper alloy is used, it shall be not more than 15 percent zinc. Metal shall not be used in combinations to cause galvanic action as specified in 12.4.

Exception: Other current collector dimensions are not prohibited from being used when they comply with the Test for Leakage Current After Heating Element Failure, Section 57.

33.3 A leakage current collector or grounded metal heater enclosure shall be insulated by nonconductive pipe at least:

a) 12 inches (305 mm) from the nearest opening to the bathtub when 2-inch (50.8-mm) or smaller inner diameter pipe is used; or

b) 27 inches (686 mm) from the nearest opening to the bathtub when pipe larger than 2 inches in diameter is used.

34 Gaskets

34.1 A gasket or seal may be provided to seal an enclosure or pump housing to comply with the Water Temperature Tests, Section 54, and the Water Exposure Test, Section 55. A gasket or seal shall comply with the requirements in Gaskets and Seals – Accelerated Aging Test, Section 60.

35 Luminaires

35.1 A luminaire, if provided, shall be an integral part of the bathtub and shall not be intended for operation at more than 150 volts to ground.

35.2 A luminaire shall be corrosion resistant, and shall be provided with reliable seals as covered by the requirements in Gaskets, Section 34.

35.3 A lens for a luminaire shall be made of tempered glass or polymeric material and shall withstand a 5 foot-pound (6.8 J) impact test as outlined in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. Polymeric material shall have a temperature index, with impact, to equal or exceed the temperature on the lens during the Temperature Test, Section 51, without water in the bathtub.

35.4 A luminaire in a hydromassage bathtub that is serviceable from the front shall require the use of a tool for servicing. There shall be no contact between the metal of the luminaire and any metal:

a) Accessible to the occupant; or

b) In contact with circulating water.

35.5 A transformer provided for a low-voltage luminaire shall comply with the requirements for transformers used to energize a circuit accessible to the tub occupant as specified in Transformers, Section 37.

35.6 Lampholders shall comply with the Standard for Lampholders, UL 496.

36 Capacitors

36.1 A capacitor provided as a part of a capacitor motor and a capacitor connected across the line (such as a capacitor for radio-interference elimination or power factor correction) shall be housed within an enclosure or container so as not to be subjected to mechanical damage and to reduce the risk of emission of flame or molten material resulting from capacitor malfunction. The container shall be of metal providing strength equivalent to that of uncoated steel having an average thickness of 0.020 inch (0.51 mm).

Exception No. 1: The container of a capacitor is not prohibited from being made of thinner sheet metal or of material other than metal when:

a) The capacitor is mounted in an enclosure that houses other parts of the unit; and

b) The enclosure complies with the requirements for enclosures of current-carrying parts in Frame and Enclosure, Section 8.

Exception No. 2: The container of an electrolytic capacitor with means for venting is required to reduce the risk of mechanical damage only, and the requirement for minimum enclosure thickness does not apply. The container of an electrolytic capacitor that is not provided with means for venting and that is spaced more than 1/16 inch (1.6 mm) from the motor is not required to comply with the requirement for enclosure thickness when the enclosure complies with the test in 62.2.1.

36.2 When a capacitor that is not a part of a capacitor motor or a capacitor-start motor is connected so that malfunction of the capacitor results in a risk of fire or electric shock, thermal or overcurrent protection shall be provided in the unit to reduce such a risk.

36.3 A capacitor using a flammable dielectric medium shall comply with the Standard for Capacitors, UL 810.

36.4 A capacitor connected across the line or between line and ground (such as a capacitor for radio-interference elimination shall be suitable for the voltage involved and comply with the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14.

37 Transformers

37.1 A transformer shall comply with the construction requirements in the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and one of the following standards:

a) Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2;

b) Transformer and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411; or

c) Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

Exception: These requirements do not apply to transformers that are part of controls that comply with the Standard for Industrial Control Equipment, UL 508, or the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills the Standard for Temperature-Indicating and -Regulating Equipment UL 873 requirements.

37.2 In addition to the requirement in 37.1, a transformer used to energize a circuit that is accessible to the occupant or in contact with circulating water shall:

a) Have its primary and secondary windings wound on and insulated from separate sections of the core;

b) If concentrically wound, insulated from and separated by a grounded copper shield at least 0.005 inch (0.127 mm) thick;

c) Comply with the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097, or the Reference Standard for Double Insulation Systems for Use in Electronic Equipment, UL 2097; or

d) Comply with the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

37.3 Except when complying with 37.2 (c) or (d), transformers shall additionally comply with the performance requirements specified UL 5085-2, or UL 1411, or UL 5085-3, or 62.4.1.

38 Switches, Receptacles, and Controls

38.1 General

38.1.1 A switch or other control device shall be provided and shall have current and voltage ratings not less than those of the circuit (load) that it controls.

38.1.2 A switch provided with a unit but not installed in the unit shall be provided with installation and operating instructions as required in 76.2.

38.1.3 A switch that is used as the control device for the unit shall open all ungrounded supply-circuit conductors directly or indirectly. The grounding conductor shall not be interrupted. The on-off positions of the switch shall be clearly marked. If a light-emitting diode or an incandescent lamp is used to indicate an on-off position of the switch, the light-emitting diode or incandescent lamp shall be rated for a minimum of 20,000 hours of life at the designated voltage indicated by the manufacturer's data.

38.1.4 The ampacity of a switch or relay that controls an inductive load, such as a transformer, or an electric-discharge lamp ballast shall be rated no less than twice the load it controls unless the switch is acceptable for the particular application.

38.1.5 A switch that controls a lampholder for an incandescent lamp other than a 15-watt or smaller pilot or indicating lamp shall be of a type that is acceptable for use with tungsten-filament lamps.

38.1.6 A switch or other device controlling a motor, a solenoid, a relay, or similar device shall be rated for the intended load.

Exception: A switch or other device controlling a motor, a solenoid, a relay, or similar device is not prohibited from being tested controlling its actual load when installed in its hydromassage bathtub. If tested in this manner, the overload test shall be in accordance with the Switch Overload Test, Section 53.

38.1.7 A switch intended to be connected to a circuit having a potential to ground of more than 150 volts shall be acceptable for the maximum potential to ground of the circuit.

38.1.8 A nominal 208-volt, single-phase or 3-phase, or a 120/240-volt, single-phase unit is considered to involve a potential to ground of less than 150 volts. A 2-wire, single-phase or a 3-wire, 3-phase unit with a rating in the range of 220 – 240 volts is considered to involve a potential to ground in excess of 150 volts.

38.1.9 A disconnecting device controlling one or more electric heating elements shall be arranged so that opening the device will de-energize all the elements and, in addition, shall open all ungrounded supply conductors in each heater circuit.

38.1.10 Receptacles shall be rated for the voltage, current, and temperature involved.

38.1.11 Switches shall comply with the Standard for General-Use Snap Switches, UL 20, or the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1.

38.1.12 Switches that comply with the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1.

38.1.13 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 the 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 6059and 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.

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

38.1.15 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.

38.1.16 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.

38.1.17 Internal plugs and connectors shall be suitable for voltage and current involved and not exceed the operating temperature rating of the component. They shall comply with either the Standard for Attachment Plugs and Receptacles, UL 498, or the Standard for Component Connectors for Use in Data, Signal, Control and Power Applications, UL 1977.

38.1.18 Electronic motor drives, if provided, shall be suitable for the pump voltage and current rating and shall comply with the Standard for Power Conversion Equipment, UL 508C.

38.2 Manually-operated switches

38.2.1 A manually-operated switch in a circuit that is capable of introducing a risk of fire, electric shock, or injury to persons shall not be accessible to an occupant of a hydromassage bathtub unless all of the following conditions are met:

a) The switch enclosure is of insulating material;

b) All live parts of the switch, other than terminals, are completely within the switch enclosure;

c) No noncurrent-carrying metal part that extends outside the switch enclosure enters the arc chamber;

d) The actuator that contacts live parts is wholly of insulating material;

e) With the exposed external parts of the actuator removed, no live part inside the switch enclosure is accessible;

f) Metal mounting screws or rivets by which the switch is secured to accessible noncurrent-carrying metal of the unit shall not pass through the enclosure of the switch (but may pass through projections of the switch enclosure or through a piece of insulating material secured to the switch); and

g) A portion of a switch that contains arcing parts shall be separated from exposed noncurrent-carrying metal by mica no less than 0.005 inch (0.13 mm) thick, or by other equivalent insulation. Metal mounting screws, rivets, clamps, or other devices that pass through or around the enclosure of the switch shall be insulated from the noncurrent-carrying metal to which the switch is secured.

38.3 Reduction of risk of injury to persons

38.3.1 When unintentional operation of a switch is capable of resulting in a risk of injury to persons, the actuator of the switch shall be located or guarded so that such operation is unlikely.

39 Sharp Edges

39.1 An enclosure, a frame, a guard, or a handle shall not be sufficiently sharp to constitute a risk of injury to persons during intended maintenance and use.

39.2 Whenever referee measurements are necessary to determine that a part as specified in 39.1 is not sufficiently sharp to constitute a risk of injury to persons, the method described in the Standard for Tests for Sharpness of Edges on Equipment, UL 1439, is to be used.

40 Temperature-Regulating Controls

40.1 General

40.1.1 A unit, when equipped with a water heater, shall be provided with a water temperature-regulating control that has a maximum set point corresponding to a water temperature of 40°C (104°F) in the bathtub, and the bathtub shall comply with 54.2.1.

Exception: The bathtub is not required to be equipped with a temperature-regulating control when the unit complies with 54.2.2.

40.1.2 When adjustable, the temperature-regulating control shall have marked settings, but it shall not have any settings shall be marked hotter than 40°C (104°F).

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

a) 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 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, with the parameters as specified in Supplement SB.

b) The circuit requirements in Supplement SA.

40.2 Temperature-regulating controls with a marked or implied "off" position

40.2.1 A temperature-regulating control with either a marked or an implied "off" position as described in 40.2.2 and 40.2.4, while in the marked or implied "off" position, shall:

a) Open all ungrounded conductors of the heater circuit; and

b) Either:

1) Be provided with a positive mechanical means such that the temperature-regulating control cannot function automatically; or

2) Not reclose (remain open) when cooled to a temperature of minus 35°C (minus 31°F).

40.2.2 A temperature-regulating control as described in 40.2.1 is considered to have an implied "off" position when:

a) The temperature-regulating control is marked with a word or phrase such as ″cold″ or ″no heat,″ that conveys the same meaning as the word ″off″; or

b) The temperature-regulating control may be placed in an unmarked "off" position that is implied by the fact that there is a marked "on" position.

40.2.3 When a temperature-regulating control described in 40.2.1 is used in combination with another temperature-regulating control, the combination of controls may be used to comply with the requirements in 40.2.1.

40.2.4 With reference to 40.2.1, a single-pole temperature-regulating control marked with:

a) ″Lo-Normal-Hi″;

b) A temperature scale such as ″32 – 38°C (90 – 100°F)″; or

c) A numerical scale that does not include the numeral 0 such as ″1 – 5″.

is not considered to have an implied "off" position.

41 Temperature-Limiting Controls

41.1 General

41.1.1 A unit equipped with a water heater shall be provided with a control such that the hydromassage bathtub complies with the abnormal operation water temperature tests specified in this standard.

41.2 Temperature-sensitive controls

41.2.1 A temperature-sensitive control shall be either a manually-resettable type or a thermal cutoff. A manually-resettable control shall be trip-free and the resetting means shall be accessible to the user.

Exception: The resetting means for the temperature-sensitive, temperature-limiting control is not required to be accessible to the user when it is necessary to disconnect power to the heater to reset the control. The control function shall not be affected by cycling of the pump. See 79.8 for an installation instruction requirement.

41.2.2 A water temperature-limiting control shall comply with either the requirements in (a), (b), or (c):

a) 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 2-9: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, with the parameters as specified in Supplement SB.

b) The Standard for Thermal-Links – Requirements and Application Guide, UL 60691.

c) The circuit requirements in Supplement SA.

41.2.3 A temperature-sensitive control shall be in addition to any temperature-regulating control.

41.2.4 A mechanical temperature-limiting device shall have no operating parts in common with a mechanical temperature-regulating control device; and an electronic temperature-limiting circuit shall have no parts in common with either an electronic temperature-regulating circuit or a mechanical temperature-regulating device; however, a common mounting bracket or enclosure may be used.

Exception: Parts may be used in common for the temperature-regulating and temperature-limiting control functions when the results of an investigation indicate that the reliability of such parts in common are suitable for the application.

41.2.5 An electromechanical temperature-limiting control shall have a maximum tolerance of ±3°C (±5°F).

41.2.6 A relay or contactor that controls the heater circuit shall not be activated by both a temperature-regulating and a temperature-limiting control.

41.2.7 When loss of electrical power to the control circuit makes the temperature-limiting control inoperative, such loss of power shall also open the electrical supply to the heater.

41.2.8 Shorting of the temperature-limiting control circuit to ground shall not defeat the purpose of the temperature-limiting control.

41.2.9 To prevent nuisance tripping when the tub is being filled, a temperature-limiting control may be automatically rendered inoperative whenever there is no power available to the heater from the temperature-regulating control.

41.3 Pressure-sensitive controls

41.3.1 Pressure-sensitive controls provided to comply with the abnormal operation water temperature tests specified in this standard shall be either a manually-resettable or an automatic-reset type.

41.3.2 Pressure-sensitive controls shall comply with either (a) or (b):

a) The Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements, UL 60730-2-6, with the parameters as specified in Supplement SB.

b) The circuit requirements in Supplement SA.

41.3.3 The resetting means of a manually-resettable control shall be accessible to the user.

41.3.4 A manually-reset type pressure-sensitive control shall be a control type designated ″Manually Reset 2″ or ″M2″ in accordance with the Standard for Temperature-Indicating and -Regulating Equipment, UL 873.

41.3.5 A relay or contactor that controls the heater circuit shall not be activated by both a temperature-regulating control and a pressure-sensitive temperature-limiting control.

41.3.6 When loss of electrical power to the control circuit makes the pressure-sensitive temperature-limiting control inoperative, such loss of power shall also open the electrical supply to the heater.

41.3.7 Shorting of the pressure-sensitive temperature-limiting control circuit to ground shall not defeat the purpose of the pressure-sensitive temperature-limiting control.

42 Temperature sensing, thermistor devices

42.1 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 a Safety Critical Function shall comply with the Standard for Thermistor-Type Devices, UL 1434.

42.2 The thermistors described in 42.1 shall be investigated for:

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

b) Temperature Excursions: Outdoor Use Conditions.

42.3 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).

43 Parts Subject to Pressure

43.1 A part that is subject to pressure developed by a pump shall be subjected to the hydrostatic pressure test described in 63.1.1.

Exception: The part is not required to be subjected to the test when it is apparent that the strength of the part is sufficient as a result of its material and dimensions.

43.2 Parts that are subject to pump pressure are considered to be those parts of the circulating system that contain valves or sufficient resistance to water flow so as to build up the pressure to the developed pressure of the pump. A water filter with direct, unvalved outlets to the bathtub will not require testing.

44 Protection Against Entrapment

44.1 Each suction opening shall be provided with a means to reduce the risk of entrapment. If provided for this purpose, a suction fitting shall:

a) Not be removable without the use of a tool;

b) Be marked with:

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

2) The model number;

3) The flow rate in gallons per minute; and

4) Any limitation of use (such as vertical use only).

c) Comply with the requirements specified in the Standard for Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, and Hot Tubs, ASME A112.19.8-2007, or the Standard for Hydromassage Bathtub Appliances, ASME A112.19.7-2006; and

d) Be suitable for the flow rate determined by the Flow Rate Test, Section 59.

Exception: A fitting with no marked flow rate need not comply with 44.1 (b)(3) and (d) if it complies with the Hair Entrapment Test requirements while installed in the tub as specified in ASME A112.19.7-2006.

44.2 The hydromassage bathtub with its suction fitting(s) installed in the intended manner shall comply with the hair entrapment test requirements specified in Hydromassage Bathtub Appliances, ASME A112.19.7-2006. The pump or jet flow, if adjustable, shall be set to maximum. The jets shall be positioned away from the fitting.

45 Direct Plug-In Controls

45.1 Except as noted below, direct plug-in controls shall meet all the Mechanical Assembly and Enclosure requirements as specified for semipermanent mounted units in the Standard for Class 2 Power Units, UL 1310.

45.2 Direct plug-in controllers shall only be intended for use on a 15- or 20-ampere, 125-volt receptacle.

45.3 For the purposes of determining moment, center of gravity and weight, the control and output cord, when provided, are to be cut off at the enclosure, or at the strain-relief means when the strain-relief means is outside the enclosure.

45.4 An integral mounting tab shall be provided to secure the control to a duplex receptacle that has a center screw.

45.5 When inserted in a duplex receptacle, no part of a direct plug-in controller, including the integral tab, control or output wiring, shall interfere with full insertion of an attachment plug into the adjacent receptacle.

45.6 A screw shall be provided so as to secure the mounting tab of the control to a duplex receptacle that has a center screw.

45.7 A direct plug-in type controller shall not be prohibited from being provided with a cord connector on a short length of cord for connection to its load. The length of the cord shall be a maximum of 6 inches (152 mm). The length shall be determined by measuring from the point of exit from the controller enclosure to the face of the cord connector.

45.8 The integral plug and receptacle or cord connector of a direct plug-in type controller shall be of the grounding type.

45.9 Direct plug-in controllers shall be designed so that no safety circuits of the bathtub are defeated when the controller is removed and the intended load plugged into the receptacle in its place.

45.10 For the purposes of evaluation of a polymeric enclosure, direct plug-in controllers shall be considered to be fixed or stationary equipment.

45.11 The integral blade assembly of direct plug-in controllers shall comply with the construction requirements in the Standard for Attachment Plugs and Receptacles, UL 498.

45.12 Direct plug-in controllers shall be provided with a single receptacle or cord connector for connection to the controlled load.

46 Ozone Generators

46.1 An ozone generator provided shall inject ozone into the water circulating system without ozone passing through the pump, heater, or current collectors, and without ozone contacting any safety circuit component or sensing device, or any check valve that is not an integral part of the ozone system.

46.2 A hydromassage bathtub with an integral ozone generator shall not offgas more than 0.1 parts ozone per million parts air (PPM) averaged over 8 hours when tested as specified in the Ozone Offgas Test, Section 61.

46.3 The maximum transitory ozone concentration shall not exceed 0.3 parts ozone per million parts air (PPM) when averaged over any 13 consecutive readings and shall not exceed 0.8 PPM when averaged over any two consecutive readings.

PERFORMANCE

47 General

47.1 All tests are to be conducted with the unit connected to a power supply of rated frequency and a voltage as follows:

a) For 110- to 120-volt rating: 120 volts;

b) For 220- to 240-volt rating: 240 volts; and

c) For other than as specified in (a) or (b): the maximum rated voltage of the unit.

47.2 A sample of the unit is to be set up or installed in accordance with the manufacturer's instructions. The sample is to be operated according to the manufacturer's instructions with regard to the intended uses of the unit, including maintenance and cleaning and lack of such maintenance and cleaning, and with all accessories recommended for use with the unit. The unit is to be operated as it would be in actual use, including manipulation of all controls and operation under the various loading conditions that can be expected.

48 Insulation Resistance Test

48.1 A hydromassage bathtub intended for permanent connection to the electrical supply shall have an insulation resistance between live parts and dead metal of not less than 250,000 ohms as determined by using a megohmmeter with a test potential of 500 volts DC. The test shall be repeated following conditioning for 48 hours at 88 ±2 percent relative humidity at 32 ±2°C (89 ±3.6°F). Prior to conditioning, the sample is to be heated to just above 34°C (93°F) to reduce the risk of condensation.

49 Starting Current Test

49.1 A unit shall start and operate as described in 50.1 on a circuit protected by a non-time-delay fuse having a current rating corresponding to that of the branch circuit to which the unit is intended to be connected. The results are in compliance when the fuse does not open and an overload protector provided as part of the unit does not trip.

Exception: A time-delay fuse is not prohibited from being used when the unit starts and operates as intended on a circuit protected by a time-delay fuse, and is marked in accordance with 71.12.

49.2 A unit with multiple sources for which the combined rating of both sources is 20 amperes or less shall be tested with both sources connected to a single branch circuit. A unit with multiple sources for which the combined rating of both sources is greater than 20 amperes shall be tested with two separate branch circuits.

49.3 To determine whether a unit complies with the requirement in 49.1, the unit is to be started three times, with the unit at ambient temperature as described in 51.4 at the beginning of the test. Each start of the motor is to be made under conditions representing the beginning of intended operation (the beginning of the intended operating cycle, in the case of an automatic unit) and the motor is to be allowed to come to rest between successive starts.

50 Power Input Test

50.1 The current input to a unit shall be no more than 110 percent of the rated value in any mode of operation of the unit, with all controls adjusted for maximum current input when the unit is connected to a supply circuit as specified in 47.1.

51 Temperature Test

51.1 A unit, when operated under conditions of intended load and while connected to a supply circuit as described in 47.1, shall not attain a temperature at any point higher than the temperatures specified in Table 51.1.

51.2 The test shall be conducted with the air induction control closed and again with the control open.

51.3 A thermal- or overload-protective device shall not open the circuit during the temperature test.

51.4 The temperatures specified in Table 51.1 are based on an assumed ambient temperature of 25°C (77°F). However, the test may be conducted within the range of 20°C – 30°C (68°F – 86°F) if the temperature is corrected to 25°C.

51.5 If a corrected temperature exceeds the values specified in Table 51.1, at the request of the manufacturer, the test may be repeated at an ambient temperature closer to 25°C (77°F).

Table 51.1
Maximum temperatures

Materials and components	°C	(°F)
A. MOTORS		
1. Class 105 insulation systems on coil windings of an AC motor having a diameter of 7 inches (178 mm) or less, not including a universal motor, and of a vibrator coil[a]		
a) In an open motor and on a vibrator coil:		
Thermocouple or resistance method	100	(212)
b) In a totally enclosed motor:		
Thermocouple or resistance method	105	(221)
2. Class 105 insulation systems on coil windings of an AC motor having a diameter of more than 7 inches, of a DC motor, and of a universal motor[a]		
a) In an open motor:		
Thermocouple method	90	(194)
Resistance method	100	(212)
b) In a totally enclosed motor:		
Thermocouple method	95	(203)
Resistance method	105	(221)
3. Class 130 insulation systems on coil windings of an AC motor having a diameter of 7 inches or less, not including a universal motor[a]		
a) In an open motor:		
Thermocouple or resistance method	120	(248)
b) In a totally enclosed motor:		
Thermocouple or resistance method	125	(257)
4. Class 130 insulation systems on coil windings of an AC motor having a diameter of more than 7 inches, of a DC motor, and of a universal motor[a]		
a) In an open motor:		
Thermocouple method	110	(230)
Resistance method	120	(248)
b) In a totally enclosed motor:		
Thermocouple method	115	(239)
Resistance method	125	(257)
5. Class 155 insulation systems on coil windings of an AC motor having a diameter of 7 inches or less, not including a universal motor[a]		

Table 51.1 Continued on Next Page

Table 51.1 Continued

Materials and components	°C	(°F)
a) In an open motor:		
Thermocouple or resistance method	145	(293)
b) In a totally enclosed motor:		
Thermocouple or resistance method	150	(302)
6. Class 155 insulation systems on coil windings of an AC motor having a diameter of more than 7 inches, of a DC motor, and of a universal motor[a]		
a) In an open motor:		
Thermocouple method	135	(275)
Resistance method	145	(293)
b) In a totally enclosed motor:		
Thermocouple method	140	(284)
Resistance method	150	(302)
B. COMPONENTS		
1. Capacitors		
a) Electrolytic[b]	65	(149)
b) Other types[c]	90	(194)
2. Fuses		
a) Class G, J, L, T, and CC:		
Tube	125	(257)
Ferrule or blade	110	(230)
b) Others	90	(194)
3. Relay, solenoid, and coils (except motors and transformers) with:		
a) Class 105 insulation systems:		
Thermocouple method	90	(194)
Resistance method	110	(230)
b) Class 120(E) insulation systems:		
Thermocouple method	100	(212)
Resistance method	120	(248)
c) Class 130 insulation systems:		
Thermocouple method	110	(230)
Resistance method	130	(266)
d) Class 155(F) insulation systems:		
Thermocouple method	130	(266)
Resistance method	140	(284)
4. Sealing compound	d	d
5. Transformers		
a) Class 105 insulation systems:		
Thermocouple method	90	(194)
Resistance method	100	(212)
b) Class 120(E) insulation systems:		
Thermocouple method	100	(212)
Resistance method	120	(248)
c) Class 130 insulation systems:		
Thermocouple method	110	(230)
Resistance method	120	(248)
d) Class 155(F) insulation systems:		
Thermocouple method	130	(266)
Resistance method	140	(284)
C. CONDUCTORS		

Table 51.1 Continued on Next Page

Table 51.1 Continued

Materials and components	°C	(°F)
1. Rubber- or thermoplastic-insulated wires and cords[c]	60	(140)
2. Copper conductors		
a) Tinned or bare strands having:		
1. A diameter less than 0.015 inch (0.38 mm)	150	(302)
2. A diameter of 0.015 inch or more	200	(392)
b) Plated with nickel, gold, silver, or a combination of these	250	(482)
D. ELECTRICAL INSULATION – GENERAL		
1. Fiber used as electrical insulation	90	(194)
2. Phenolic composition used as electrical insulation:		
a) Laminated	125	(257)
b) Molded	150	(302)
3. Varnished-cloth insulation	85	(185)
E. SURFACES SUBJECT TO CONTACT AND USER MAINTENANCE		
1. Handles or knobs that are grasped for lifting, carrying, or holding		
a) Metallic[e]	50	(122)
b) Nonmetallic[e]	60	(140)
2. Handles or knobs that are contacted but do not involve lifting, carrying or holding; other surfaces that are subject to contact and user maintenance		
a) Metallic[e]	60	(140)
b) Nonmetallic[e]	85	(185)
3. Surfaces other than a heating function surface and known to be hot due to proximity to the heating function surface		
a) Metallic[e]	70	(158)
b) Nonmetallic[e]	95	(203)
F. OTHER		
Any part within a field wiring compartment or terminal box[f]	60	(140)
Any point of plywood sides or bottom, of simulated installation[g]	50	(122)

[a] At a point on the surface of a coil where the temperature is affected by an external source of heat, the temperature measured by means of a thermocouple may be more than the temperature specified by:

1) 5°C (9°F) for Class 105 insulation systems; and

2) 10°C (18°F) for Class 130 or Class 155 insulation systems.

[b] For an electrolytic capacitor that is physically integral with or attached to a motor, the maximum acceptable temperature on insulating material integral with the capacitor enclosure shall be not more than 90°C (194°F).

[c] A component that has been investigated and found to function without risk of fire or electric shock at a higher temperature may be used at that temperature.

[d] Unless a thermosetting material, the maximum temperature of the sealing compound shall be not more than 15°C (27°F) below the softening point of the compound as determined by the Standard Test Methods for Softening Point by Ring-and-Ball Apparatus, ASTM E28, when corrected to a 25°C (77°F) ambient temperature.

[e] A handle or knob made of a material other than metal that is plated or clad with metal having a thickness of 0.005 inch (0.127 mm) or less is considered to be a nonmetallic part.

[f] Any point within a field wiring compartment or terminal box that attains a maximum temperature of more than 60°C (140°F) but not more than 90°C (194°F) shall comply with the marking requirements specified in 71.15 and Table 71.1.

[g] The ambient temperature under the tub shell shall not exceed 50°C (122°F) for cord-connected units. Units intended to terminate permanent wiring systems shall not exceed the limits of the wiring in the field wiring compartment, tub shell or piping and other water circulation fittings. The maximum limit for thermoplastic tub shells is considered to be 65.5°C (150°F). The maximum limit for schedule 40 PVC piping is considered to be 60°C (140°F).

51.6 In conducting a test to determine whether a unit complies with the temperature requirements, the unit is to be enclosed in a box representing the minimum dimensions specified by the installation instructions. Walls and floors are to be formed of black painted 3/8-inch (9.53-mm) thick sheets of plywood.

51.7 For a unit without a heater, the water in the bathtub shall be 40°C (104°F) at the start of the test, and additional water shall be added as necessary to maintain this temperature within 3°C (5°F). For a unit with a heater, the test shall be conducted as described in 54.1.

51.8 For a unit provided with a luminaire, the temperatures of the luminaire and the luminaire lens shall be recorded with and without water in the unit.

51.9 The temperature test is to be continued until thermal equilibrium is attained, or 4 hours, whichever comes first. Thermal equilibrium is considered to exist when 3 successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5 minute intervals, indicate no change.

51.10 Coil winding temperatures are to be measured by thermocouples or by using the change-of-resistance method. For a coil of an alternating-current motor, other than a universal motor, the thermocouple is to be mounted on the integrally applied insulation on the conductor. For any other motor, the thermocouple may be applied on the outer surface of a wrap that is not more than 1/32 inch (0.8 mm) thick and consists of cotton, paper, or rayon.

51.11 Temperatures, other than as noted in 51.10, are to be measured by thermocouples consisting of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). When thermocouples are used in determining temperatures in electrical equipment, it is standard practice to use thermocouples consisting of 30 AWG iron and constantan wire and a potentiometer type instrument; and such equipment will be used whenever referee temperature measurements by thermocouples are necessary. The thermocouples and related instruments are to be accurate and calibrated. The thermocouple wire is to conform with the requirements for Special Tolerances thermocouples as listed in the Tolerances on Initial Values of EMF versus Temperature tables in the Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples, ANSI/ASTM E230/E230M. The thermocouples are to be waterproof if immersed in water during testing.

51.12 When using the resistance method, the windings are to be at room temperature at the start of the test, and the temperature of a winding is to be calculated using the formula:

$$T = \frac{R}{r}(k + t) - k$$

in which:

T is the final temperature in °C;

R is the resistance of the coil in ohms at the end of the test;

r is the resistance of the coil in ohms at the beginning of the test;

k is 234.5 for copper and 225.0 for electrical conductor grade (EC) aluminum (values of the constant for other conductors are to be determined); and

t is the temperature of the coil in °C at the time resistance r is being measured.

52 Dielectric Voltage-Withstand Test

52.1 General

52.1.1 While at the maximum operating temperature reached during intended use, each unit shall be subjected to the application of 60 hertz potentials as specified in Table 52.1. The test transformer shall have a capacity of 500 volt-amperes or more and an output voltage that is essentially sinusoidal. The applied potentials shall be increased gradually from zero to the required values and then maintained for 1 minute. The results are in compliance when there is no dielectric breakdown.

Table 52.1
Dielectric voltage-withstand potentials

Potential applied between	Unit rating, volts	Test potential, volts
Live parts of a primary or line voltage part and noncurrent-carrying metal	250 or less	1000
Primary and secondary transformer windings	Any	2500
Secondary transformer windings and noncurrent-carrying metal[a]	Any	1000 plus twice the secondary voltage

[a] See 52.2.1 for Class 2 circuits.

52.2 Class 2 circuits

52.2.1 The dielectric voltage-withstand potential for parts of opposite polarity in Class 2 circuits shall be 500 volts for the test described in 52.1.1.

52.3 Printed-wiring boards

52.3.1 When electrical breakdown of a printed-wiring board results in a risk of electric shock, the board shall withstand 1000 volts plus twice the maximum peak circuit potential between printed wiring parts and between printed-wiring parts and other parts. The measurement is to take into consideration any likely malfunction of a regulating device or circuit or the possibility of a lead being disconnected.

52.3.2 To obtain the maximum voltage, any automatic voltage-regulating device is to be rendered inoperative unless, upon investigation, it is determined that the automatic voltage-regulating device can be relied upon to reduce the risk of a voltage increase. The investigation is to take into consideration any risk of the regulating device or the unit ceasing to function as intended and, if appropriate, the possibility of the device being disconnected.

52.3.3 A connector or comparable part that is likely to be disconnected during intended operation or user servicing is to be both connected and disconnected during the test, so that the maximum voltage may be obtained.

53 Switch Overload Test

53.1 Unless rated for the application, a switch that controls a motor shall be tested by interrupting the locked rotor current of the motor 50 times at a rate of 10 cycles per minute. Exposed dead metal of the motor shall be grounded through a 3-ampere plug fuse, and any single-pole, current-rupturing device shall be located in the ungrounded supply conductor. The unit is to be connected to a supply of rated frequency and maximum rated voltage. The results are in compliance when the grounding fuse does not open, and the switch contacts do not cease to function as intended.

53.2 Unless rated for the application, a switch that controls a solenoid, a relay, or a similar device is to be tested as described in 53.1 when connected to a supply of rated frequency at 110 percent of rated voltage. The load on the device is to be the actual load controlled during intended use or an equivalent load.

54 Water Temperature Tests

54.1 General

54.1.1 For all water temperature tests, a unit with a water heater is to be installed and operated as described in the Temperature Test, Section 51. The tub shall be filled to a level 2 inches (51 mm) above the highest jet, with the jets in the horizontal position (when they are adjustable). The unit shall be operated until maximum water temperatures have been obtained, to a maximum of 4 hours. Operation shall be conducted in an ambient temperature with the range of 20°C – 30°C (68°F – 86°F). Units with temperature-regulating or temperature-limiting controls with sensing that is affected by the local ambient temperature under the tub shell shall have the maximum water temperatures corrected for a 25°C room ambient.

54.1.2 For units with heated air blowers, all water temperature tests shall be conducted both with and without the blower operating.

54.2 Normal operation

54.2.1 A unit shall be operated with all controls in the circuit and the regulating control, if provided, set to the highest setting. Air injection controls shall be closed. Jets, when adjustable, shall be adjusted to the lowest flow setting. The unit shall be operated until maximum water temperatures have been obtained, to a maximum of 4 hours. The test shall be conducted started with the water in the tub at 40°C (104°F). Results are in compliance when:

a) The maximum water temperature at the suction fitting does not exceed 43°C (109°F);

b) The water temperature at any inlet to the tub does not exceed 50°C (122°F); and

c) The temperature-limiting control does not operate.

54.2.2 To determine compliance with the Exception to 40.1.1, the unit is to be operated as described in the Temperature Test, Section 51, except with 40°C (104°F) water in the bathtub. The bathtub is to be filled to a level 2 inches (51 mm) above the highest jet. The unit is to be operated until maximum water temperatures have been obtained, to a maximum of 4 hours. Air intakes to the jets shall be closed. The results are in compliance when, after the temperature stabilizes:

a) The maximum water temperature at the suction fitting does not exceed 43°C (109°F);

b) The water temperature at any inlet to the tub does not exceed 50°C (122°F); and

c) The temperature-limiting control does not operate.

54.2.3 Testing shall be conducted with any user controls set to achieve the maximum water temperatures in the tub.

54.3 Abnormal operation

54.3.1 General

54.3.1.1 For the abnormal operation tests specified in 54.3.2.1 – 54.3.7.1, results are in compliance when:

a) There is no damage to the heater, electrical components, wiring, water pipe, or electrical conduit;

b) There is no fire;

c) There is no damage to thermal or electrical insulation; and

d) The temperature of the water entering the tub does not exceed 50°C (122°F).

54.3.2 Low water tests

54.3.2.1 A unit with a water heater, while at maximum intended operating temperature in accordance with the Temperature Test, Section 51, shall be operated without the temperature-regulating control until ultimate results occur with no water in the tub and with the water in the tub:

a) Below the heater enclosure;

b) Below the suction fitting(s); and

c) At a level just before any pressure-sensitive controls activate.

The tests in (a) – (c) may be conducted in any convenient sequence.

54.3.2.2 If a unit is provided with a temperature sensing device to provide dry-fire protection or other control circuitry to deactivate the water heater in the event of operation without water, three samples of the heater assembly shall be subjected to 50 cycles of operation without water. Each cycle shall begin at room temperature or other temperature, with the concurrence of all concerned, and shall end when heater temperatures stabilize. Temperatures inside the heater enclosure shall be monitored to ensure that the resulting temperatures do not exceed the thermal index of the material being used. The calibration of the three thermostats shall be checked after this test to determine that they are still within the tolerance specified in 41.2.5. If only one of the three thermostats is not within the specified tolerance, the test may be repeated with three new thermostat samples. To be in compliance, all three additional thermostats must be within the tolerance after the test.

54.3.3 Interrupted power

54.3.3.1 A unit provided with a water heater shall be operated until maximum intended operating temperatures are obtained, and the power supply is then to be interrupted. The temperature of the water in the heater shall be monitored and, as the temperature reaches a maximum value, the power shall be restored. For this test, all temperature controls shall be in operation.

54.3.4 Water flow interruption

54.3.4.1 When either a pump-motor protective device or a pump-motor circuit breaker or fuse can operate without disconnecting power to the heater, the test in 54.3.3.1 shall be repeated with interruption of power to the pump motor alone.

54.3.5 Temperature-regulating control failure

54.3.5.1 A unit is to be operated as described in 54.1.1 – 54.2.1 with the temperature-regulating control shunted or the heater otherwise wired so that the temperature-limiting control will be the only device in the circuit that will limit the temperature of the water.

54.3.6 Blocked suction fitting

54.3.6.1 A unit is to be operated as described in 54.1.1 – 54.2.1 with the suction fitting partially or completely blocked, whichever results in maximum water temperatures. For units provided with pressure-sensitive limit controls, the suction fitting shall be blocked to just below the point where the pressure-sensitive limit control activates.

54.3.7 Blocked jet

54.3.7.1 A unit is to be operated as described in 54.1.1 – 54.2.1 with any adjustable jets partially or completely blocked, whichever results in maximum water temperatures.

55 Water Exposure Test

55.1 General

55.1.1 A unit, enclosed as intended, shall be subjected to splashing, flooding, seal damage, and reverse siphoning. The results are in compliance when, after each test:

a) The unit complies with the Dielectric Voltage-Withstand Test, Section 52; and

b) There is no visible wetting of live parts or insulation used as the support surface of live parts.

55.1.2 In the tests specified in 55.2.1 and 55.3.1, the water is to have a resistivity of 300 ohm-centimeters.

55.2 Splashing

55.2.1 A unit, installed as intended, shall be tested to simulate splashing by having 20 gallons (75.7 liters) of water poured over any surface. The test is to be conducted with the unit operating and repeated with the unit not operating.

55.3 Flooding

55.3.1 A unit with internal hose connections to pumps or other equipment shall be tested with any one hose connection disconnected to simulate a fault or a loose connection. The test shall be repeated with each connection opened in turn.

55.3.2 A pump not previously so investigated shall be tested to determine the effect of damage to each shaft seal. One of the following methods is to be used:

a) The pump is to be operated dry for 7 hours and then operated pumping water for 1 hour; or

b) For pumps with seals that can be so treated, the seal face may be scored with a triangular file to the depth of 1/16 inch (1.6 mm) in two locations and, after reassembly, the pump is to be operated pumping water for 7 hours.

56 Available Current Test

56.1 The available current (isolated or ground-referenced) from a circuit that is accessible to the occupant or in contact with circulating water shall not exceed the limits for a risk of electric shock as specified in 4.20 when measured as described in 56.2 – 56.4.

56.2 The available current is to be measured between any part accessible to the tub occupant or in contact with the tub water and:

a) Any other part accessible to the tub occupant;

b) The grounded supply conductor;

c) The supply equipment grounding conductor; and

d) Any two points on a control accessible to the bathtub occupant. The outer layer of a membrane switch shall not be relied upon for mitigation of the risk of electric shock.

56.3 The measurements are to be made with the tub insulated from ground. Water in the tub is to have a resistivity of 300 ohm-centimeters. Current available from the tub water is to be measured to a copper electrode plate having dimensions twice the internal diameter of the pipes through which the water circulates in the tub. The electrode is to be placed 1 inch (25.4 mm) from the inside wall of the tub directly over each water discharge and water pick-up port, one at a time.

56.4 The measurements shall be taken by:

a) Using a milliammeter with an internal impedance not exceeding 500 ohms; or

b) Measuring the voltage drop across a non-inductive resistor not exceeding 500 ohms.

57 Test for Leakage Current After Heating Element Failure

57.1 If provided with an electric water heater with a nonmetallic enclosure, a unit with a protective circuit in lieu of current collectors or with current collectors as described in the Exception to 33.2 shall be tested as described in 57.2 – 57.6. Test results are in compliance when the leakage current does not exceed 0.5 milliampere.

57.2 For this test, the unit is to be supplied through an isolating transformer of sufficient capacity to maintain the required supply voltage. The ungrounded conductor(s) for the unit shall be connected to one end of the secondary winding. The other end of the secondary winding is to be connected to:

a) The enclosure ground terminal;

b) The neutral conductor; and

c) One side of the measuring circuit.

57.3 The heating element is to be altered to meet the description in Figure 57.1 so that 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.

57.4 Measurements are to be made under the conditions specified in Performance, General, Section 47, with the unit 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.

57.5 The current flow is to be measured, using a milliammeter with no more than 50 ohms impedance, to a copper electrode plate having dimensions approximately twice the internal diameter of the pipes through which the water circulates in the bathtub. The electrode is to be placed 1 inch (25.4 mm) from the inside walls of the bathtub directly over each water discharge and water pick-up port, one at a time.

57.6 An investigation of the construction of the unit is to be made to determine if the leakage current is limited by:

a) Drainage to grounded metal;

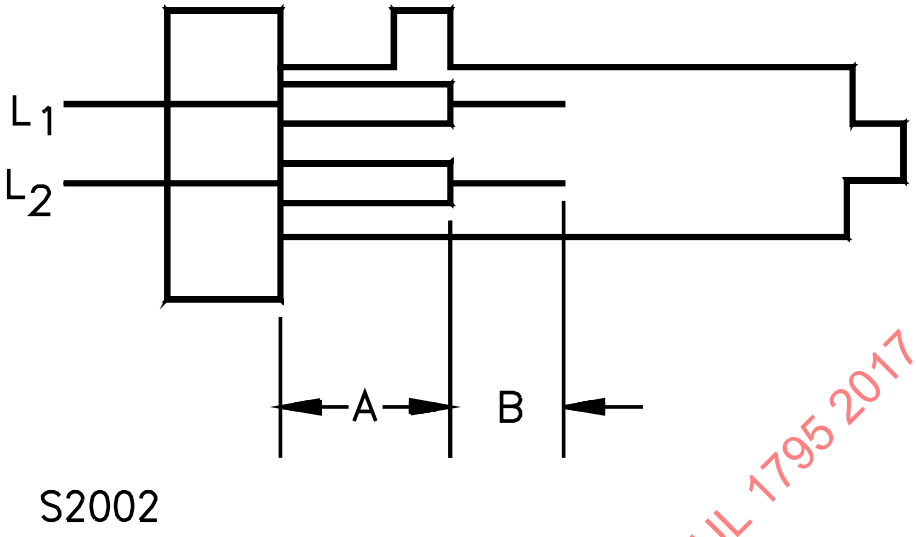
b) Impedance of the water path between the heater and the bathtub;

c) Protective devices in the circuit; or

d) A combination of any of these factors.

The reliability of these features for the anticipated life of the equipment is to be determined.

Figure 57.1
Altered element



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

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

58 Grounding Impedance Test

58.1 The impedance between the point of connection of the equipment grounding means and any other metal part that is required to be grounded in accordance with the requirements in 17.1 shall be not more than 0.1 ohm when measured with a digital ohmmeter. For cord-connected units, the impedance is measured from the grounding pin of the cord attachment plug and any other metal part of the unit.

59 Flow Rate Test

59.1 The flow rate of a unit is to be measured while the unit is operated at maximum pump speed and as described in the Temperature Test, Section 51, using a flow meter. The flow meter is to be attached to the suction side of the water pump in the unit or, if possible, to each suction opening in turn. If agreeable to all concerned, the suction fitting may be attached to the inlet of the flow meter. The flow meter shall use the same size plumbing as used in the unit. If a unit is provided with more than one suction opening, the flow rate of each suction opening in turn shall be measured with every other opening blocked, one at a time, to attain the maximum flow rate. The maximum flow rate shall be used to rate the unit or, if applicable, each opening. Filters are to be removed or bypassed during this test if the unit can operate in this condition.

60 Gaskets and Seals – Accelerated Aging Test

60.1 The test procedure for determining whether a component complies with the requirement in 34.1 is based on the material of which it is composed, its size and shape, the mode of application in the appliance, and other factors. As determined necessary, the test procedure is to include a visual inspection for determination of cracks and deformation after artificial aging, and a comparison of hardness, tensile strength, and elongation before and after artificial aging.

60.2 With reference to 34.1, a gasket or seal, when tested to compare its tensile strength, elongation, and compression set before and after artificial aging, shall have values that are not less than the minimum corresponding values specified in the Standard for Gaskets and Seals, UL 157. The maximum service temperature specified in UL 157 corresponds to the temperature of the component during the Temperature Test, Section 51.

60.3 A boot shall comply with requirements for nonelastomeric material, and a diaphragm (compressed at circumference) shall comply with requirements for elastomeric material.

61 Ozone Offgas Test

61.1 The ozone offgas test is to be conducted in a smoke-free, draft-free, non-ventilated, relatively airtight insulated room which is maintained at 50 percent relative humidity while at 20 – 30°C (68 – 86°F) for 30 minutes prior to the start of the test. The test room is to be the smallest recommended width as specified in the Installation Instructions for the bathtub. The length of the room is to be 8 feet (2.4 m). The ceiling height is to be 8 feet (2.4 m). All interior surfaces are to be covered with a material that does not react with ozone. The door to the test room is to be sealed during the test.

61.2 The tub to be tested is to be located at one end of the test room and filled with tap water to the level recommended by the manufacturer. A fresh water sample is to be used for each test.

61.3 Ozone test probes are to be located above any inlet that admits ozone into the tub, 6 inches (152 mm) above the water surface and 6 inches from the side of the tub. One additional test probe is to be located below the ozone generator. When the tub inlets that admit ozone cannot be determined by examination, then the tub and the ozone generator are to be operated to maximize ozone offgas and a sampling of all tub inlets is to be made the day prior to the ozone offgas test.

61.4 Ozone offgas is to be measured using an ozone monitor that takes at least 1 measurement every 30 – 45 seconds with a minimum range of 0.03 – 5.0 parts ozone per million parts air (PPM) increments with an accuracy within ±5 percent. All test equipment is to be located outside the test room and the exhaust from the monitor (the tested air sample) is to be plumbed back into the test room. All plumbing is to maintain the airtight integrity of the test room. Prior to each test, the ozone monitor is to be purged and calibrated according to the monitor manufacturer's instructions.

61.5 Ozone measurements are to be taken 5 minutes before the test and then continuously until 5 minutes after the test. During the test, the tub and the ozone generator are to be operated to maximize ozone offgas. Operation is to continue until ozone measurements stabilize at all test probe locations. Stabilization occurs when there is no increase in the average ozone level during 3 successive intervals of not less than 10 percent of the previous elapsed test duration, except that the first interval is to be no less than 120 minutes. Measurements are to continue for 5 minutes after the ozone generator is turned off. An extrapolated 8-hour average of the ozone concentration is to be calculated from the measurements taken with the ozone generator operating. The average ozone level measured during the 5 minutes before the test was started (background) is to be subtracted from the results.

61.6 Ozone measurements made during the test specified in 61.5 shall not exceed the limits specified in 46.2 and 46.3.

61.7 Ozone measurements made during the 5 minutes after the test shall not exceed the transitory offgas limits specified in 46.3.

62 Abnormal Operation Tests

62.1 Water back flow

62.1.1 As specified in 31.1, interrupting the operation of a blower or a fan shall not result in water contacting any live part or electrical insulation. The test is to be conducted:

a) By interrupting power to the blower with the water circulating pump operating; and

b) By interrupting power simultaneously to the blower, pump, heater, and other components.

If water does not flow into the air lines due to the air lines being routed to a point above the water level, a determination shall be made that displacement of water in the bathtub will not result in water passing the high point in the air line.

62.1.2 If a blower introduces air directly into the water-circulating pipes, interference with the flow of aerated water into the bathtub shall not result in water contacting any live part or electrical insulation. With the unit operating at maximum water flow, the water flow shall be obstructed at all outlets simultaneously for 1 minute. The results are in compliance when water does not contact any live part or electrical insulation. This determination is to be made with the blower operating and again with it not operating.

62.2 Electrolytic capacitor

62.2.1 Three samples of the capacitor described in Exception No. 2 to 36.1, mounted in the intended manner and with cotton placed around openings in the enclosure, are each to be subjected to an overvoltage to cause the capacitor to cease to function. The results are in compliance when the cotton does not ignite during the test.

62.3 Rotating parts test

62.3.1 A unit using a series motor is to be operated for 1 minute at the no-load speed resulting from application of 1.3 times rated voltage. A unit in which the rotating load may be varied is to be tested for any condition of load.

62.4 Transformer test

62.4.1 As specified in 37.2, each of three transformer samples is to be placed on a tissue-paper covered softwood surface and then covered with a layer of cheesecloth. A three-ampere cartridge fuse is to be connected in series from the core and the shield, when applicable, of each transformer to ground. With all secondaries short-circuited, each transformer is to be energized as specified in 47.1 for 7 hours or until ultimate results occur. The transformer is to be protected by a branch circuit type overcurrent device as specified in 49.1. Overcurrent protection, when provided in the transformer circuit of the bathtub, is to be wired to the test transformers. Results are in compliance when:

a) The ground fuse remains intact;

b) Each transformer withstands the Dielectric Voltage-Withstand Test, Section 52, for one minute; and

c) There is no ignition of the cheesecloth or tissue paper.

62.5 Dry-fire control operation

62.5.1 When a unit is provided with a temperature-sensing device to provide dry-fire protection or other control circuitry to deactivate the water heater in the event of operation without water, three samples of the heater assembly are to be subjected to 50 cycles of operation without water. Each cycle is to begin at room temperature or other temperature, with the concurrence of all concerned, and shall end when heater temperatures stabilize. Temperatures inside the heater enclosure are to be monitored to ensure that the resulting temperatures do not exceed the thermal index of the material being used. The calibration of the three thermostats are to be checked after this test to determine that they are still within the tolerance specified in 41.2.5. When only one of the three thermostats is not within the specified tolerance, the test may be repeated with three new thermostat samples. To be in compliance, all three additional thermostats must be within the tolerance after the test.

63 Tests for Parts Subject to Pressure

63.1 Hydrostatic pressure test

63.1.1 Two samples of any part subjected to pump pressure as described in 43.2 are to be filled with water to exclude all air and then are to be connected to the pump. The pressure is to be increased gradually to five times the pressure reached during normal use and then is to be maintained at that test value for 1 minute. Leakage at a gasket is not prohibited when it occurs at a pressure at least 60 percent of the test value.

63.2 Reverse hydrostatic pressure test

63.2.1 Three samples of the check valve shall be subjected to a reverse hydrostatic pressure test. The results are in compliance when, in 1 hour, over the range of water pressures given in 31.2, the valves do not leak sufficient water to wet a piece of absorbent paper placed beneath the valve assembly with the valve oriented with the blower side directed vertically downward.

63.3 Check valves

63.3.1 Three samples of the check valve shall be subjected to the reverse hydrostatic pressure test in 63.2.1 both before and after endurance cycling. The samples shall be cycled 6000 times prior to the second reverse hydrostatic pressure test. The pressure used for the endurance cycling shall be such that the cycling causes the most deterioration to the seals used, not to exceed the maximum working pressure of the unit.

63.3.2 Three samples of the check valve shall be subjected to the reverse hydrostatic pressure test in 63.2.1 both before and after endurance cycling. Prior to the first reverse hydrostatic pressure test, the samples shall be subjected to seven hours of aging in a circulating air oven maintained at 70°C (158°F). The sample shall be removed and allowed to cool to room temperature prior to the endurance cycling. The endurance cycling shall be as specified in 63.3.1.

64 Metallic Coating Thickness Test

64.1 In accordance with 12.7, the thickness of a zinc or cadmium coating shall be determined as follows:

a) A solution is to be made from distilled water containing 200 grams per liter of American Chemical Society (ACS) reagent grade chromic acid, CrO_3, and 50 grams per liter of ACS reagent grade concentrated sulfuric acid, H_2SO_4. The latter is equivalent to 27 milliliters per liter of concentrated sulfuric 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 (0.635 mm) inside bore and 5.5 inches (139.7 mm) long. The lower end of the capillary tube is to be tapered to form a tip, the drops from which are about 0.05 milliliter each. A small glass tube is to be inserted in the top of the funnel through a rubber stopper and its position is to be adjusted so that, when the stopcock is open, the rate of dropping is 100 ±5 drops per minute. If desired, 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 are to be between 21°C (70°F) and 32°C (90°F).

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

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

f) The stopcock is to be opened and the time in seconds is to be measured with a stop watch until the dropping solution dissolves off the protective metallic coating, exposing the base metal. The end point is the first appearance of the base metal, recognizable by the change in color.

g) Each sample is to be tested 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 metallic coating is expected to be the thinnest. On enclosures made from precoated sheets, the external corners that are subject to the greatest deformation may have thin coatings.

h) The thickness of the coating is determined by selecting from Table 64.1 the thickness factor for the temperature at which the test was conducted and multiplying the value by the time in seconds that was required to expose base metal.

Table 64.1
Thickness factors

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

65 Strain Relief Test

65.1 A strain-relief device shall withstand, without damage to the cord or conductors and without displacement, a direct pull of 35 pounds (156 N) applied to the cord for 1 minute. Supply connections within the equipment are to be disconnected from terminals or splices during the test.

66 Leakage Current Test

66.1 A cord- and plug-connected unit shall be subjected to a leakage current test in accordance with 66.2. The results are in compliance when the leakage current does not exceed:

a) 0.5 milliampere to an accessible metal part or to metal foil in contact with an outer enclosure of insulating material;

b) 3.5 milliamperes to the grounding pin of the attachment plug or the grounded conductor of the supply circuit; or

c) 0.5 milliampere to the water.

66.2 The leakage current is to be measured through a 500-ohm, non-inductive resistor in parallel with a 0.45-microfarad capacitor connected between the grounded side of a power supply circuit and the part to be tested with the outer enclosure of the unit (or the foil) well insulated from ground. Measurement from the water is to be made using a milliammeter with no more than 50 ohms impedance. The supply voltage is to be in accordance with Performance, General, Section 47. The measurement is to be made with the unit operating, and under conditions of nonoperation.

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

66.4 All exposed conductive surfaces are to be tested for leakage currents. The leakage currents from these surfaces are to be measured to the grounded supply conductor individually as well as collectively where simultaneously accessible and from one surface to another where simultaneously accessible. Parts are considered to be exposed surfaces unless guarded by an enclosure considered to reduce the risk of electric shock as defined in 10.1. Surfaces are considered to be simultaneously accessible when they can be readily contacted by one or both hands of a person at the same time.

66.5 If a material other than metal is used for the bathtub shell or part of the bathtub shell, the leakage current is to be measured using a metal foil with dimensions of 10 by 20 centimeters in contact with the surface. Where the surface is less than 10 by 20 centimeters, the metal foil is to be the same size as the surface. The metal foil is not to remain in place long enough to affect the temperature of the appliance. The water is to have a resistivity of 300 ohm-centimeters. Measurements from the water are to be made with a copper electrode plate having dimensions approximately twice the internal diameter of the pipe through which the water circulates. The electrode is to be placed 1 inch (25.4 mm) from the inside walls of the bathtub directly over each water discharge and water pick-up port, one at a time.

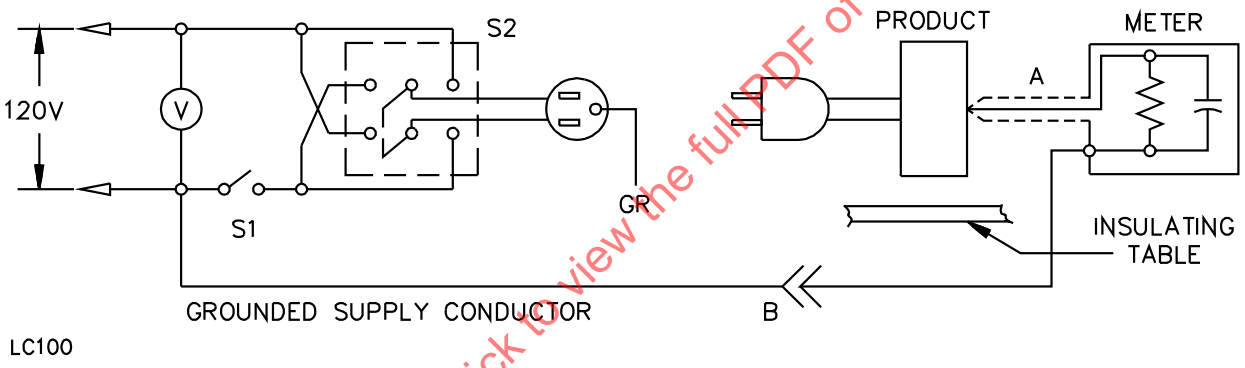
66.6 The measurement circuit for leakage current is to be as shown in Figure 66.1. The ideal instrument is defined in (a) – (c). The meter that is actually used for a measurement need only indicate the same numerical value for a particular measurement as would the defined instrument. The meter used is not required to have all the attributes of the defined instrument.

a) The meter is to have an input impedance as indicated in 66.2.

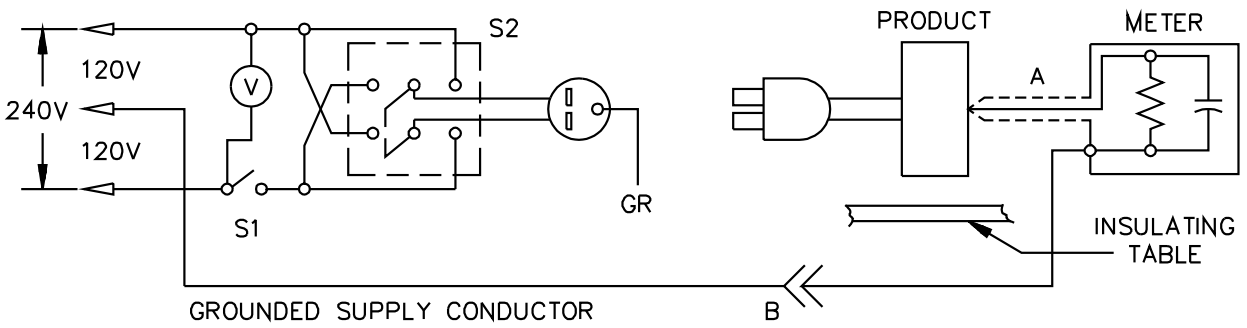
b) The meter is to indicate 1.11 times the average of the full-wave rectified composite waveform of voltage across the resistor or current through the resistor.

c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) equal to the ratio of the impedance of a 500-ohm resistor shunted by a 0.45 microfarad capacitor to 500 ohms. At an indication of 0.5 milliampere or 3.5 milliamperes, the measurement is to have an error of no more than 5 percent at 60 hertz.

Figure 66.1
Leakage current measurement circuits

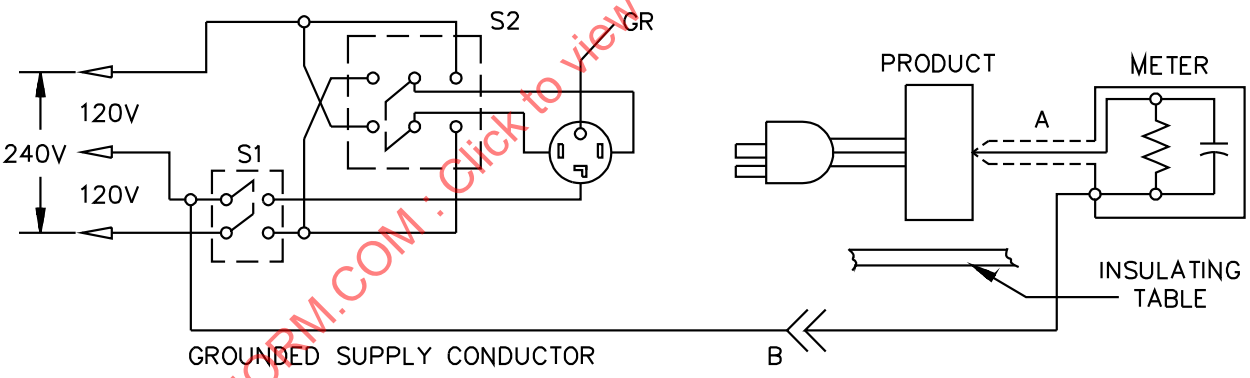


Product intended for connection to a 120-volt, grounded-neutral power supply.



LC200

Two-pole, 240-volt product connected to a 120-/240-volt, 3-wire, grounded-neutral power supply for test purposes.



LC300

Product intended for connection to a 120-/240-volt, 3-wire, grounded-neutral power supply.

A – Probe with a shielded lead.

B – Separated and used as a clip when measuring current from one part of a product to another.

66.7 A sample of the unit is to be tested for leakage current in the as-received condition without prior energization, and under conditions of maximum normal operating temperatures. Each test is started with all switches closed and with the grounding conductor open. The supply voltage is to be adjusted to rated voltage. The test sequence, with reference to Figure 66.1, is to be as follows:

a) With switch S1 opened, the unit is to be connected to the measuring circuit. Leakage current is to be measured using both positions of switch S2 and with the unit switching devices in all intended operating positions.

b) Switch S1 is then to be closed, energizing the unit, and within a period of five seconds the leakage current is to be measured using both positions of switch S2 and with the switching devices in all their intended operating positions.

c) Leakage current is to be monitored until thermal stabilization is reached as in the temperature test.

66.8 The complete leakage current test program described in 66.7 is to be conducted without interruption for other tests.

Exception: With the concurrence of those concerned, the leakage current tests may be interrupted for the purpose of conducting other nondestructive tests.

67 Tests for Field-Installed Heaters

67.1 When installed in the intended hydromassage bathtub(s), a field-installed heater shall comply with the applicable performance requirements in Section 47 – 66.

68 Direct Plug-In Controls

68.1 Except as noted below, direct plug-in controls shall meet all the Performance requirements specified in this standard.

68.2 The Temperature Test, Section 51, shall be conducted in a 50°C (122°F) ambient.

Exception: When agreed upon by all parties involved, the Temperature Test is not prohibited from being run with the controller installed in a simulated bathtub installation.

68.3 Direct plug-in controls shall comply with the Direct Plug-In Blade Secureness Test , the Direct Plug-In Security of Input Contacts Test, the Impact on Direct Plug-In Units Test , the Rod Pressure on Direct Plug-In Units Test, and the Resistance to Crushing on Direct Plug-In Units Test as specified in the Standard for Class 2 Power Units, UL 1310.

68.4 Direct plug-in controls with integral output cords per 45.7 shall comply with the Strain Relief and Push-Back Relief Tests as specified in the Standard for Class 2 Power Units, UL 1310.

MANUFACTURING AND PRODUCTION-LINE TEST

69 Dielectric Voltage-Withstand Test

69.1 Each unit shall withstand without electrical breakdown, as a routine production-line test, the application of a potential at a frequency within the range of 40 – 70 hertz:

a) Between the primary wiring, including connected components, and accessible dead metal parts that are likely to become energized; and

b) Between primary wiring and accessible low-voltage (30 volts AC or less) metal parts, including terminals.

69.2 For a unit with a motor rated 1/2 horsepower or less, the potential shall be either 1000 volts AC for 60 seconds or 1200 volts AC for 1 second. For a unit with a motor rated more than 1/2 horsepower, the potential shall be either:

a) 1000 + 2V for 60 seconds; or

b) 1200 + 2.4V for 1 second,

where V is the maximum marked voltage but not less than 120 volts if the marked voltage is within 105 – 120 volts and not less than 240 volts if the marked voltage is within 210 – 240 volts.

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

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

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

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

69.5 The test equipment shall include a transformer having an essentially sinusoidal output, a means of indicating the test potential, an audible or visual indicator of electrical breakdown, and either a manually-reset device to restore the equipment after electrical breakdown or an automatic feature that rejects any unacceptable unit.

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

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

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

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

c) In the case of equipment having a single test-potential output, a marking in a readily visible location to indicate the test potential. When a marking is used without an indicating voltmeter, the equipment shall include a positive means, such as an indicator lamp, to indicate that the manually-reset switch has been reset following a dielectric breakdown.

69.8 During the test, the primary switch is to be in the on position, both sides of the primary circuit of the unit are to be connected together and to one terminal of the test equipment, and the second test equipment terminal is to be connected to accessible dead metal. All switches, relays, and controls are to be activated such that all circuits are tested.

RATINGS

70 General

70.1 A hydromassage bathtub shall be rated to indicate the voltage, amperage, frequency, and the number of wires required in the power supply circuit. The number of phases shall be included in the rating if the unit is for use on a polyphase circuit. A unit that is shipped from the factory with provision for connection to two sources of supply or has provision for field installation of an option on a second source shall be provided with an electrical rating for both sources.

Exception: The rating is not required to include the number of wires for a unit intended for connection to a nominal 120-volt, 60-hertz source of supply.

MARKINGS

71 General

71.1 A unit shall be legibly and permanently marked with:

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

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

c) A distinctive catalog or model number; and

d) The electrical ratings as described in Ratings, General, Section 70.

The marking shall be located so as to be visible after installation.

Exception No. 1: The manufacturer's identification is not prohibited from being in a traceable code when the unit is identified by the brand or trademark owned by a private labeler.

Exception No. 2: The date of manufacture is not prohibited from being abbreviated, or in a nationally-accepted conventional code, or in a code affirmed by the manufacturer.

71.2 The repetition time cycle of a date code shall be no less than 10 years. The date code shall not require reference to the manufacturer's records to determine when the equipment was manufactured.

71.3 A marking that is required to be legible and permanent shall be in letters at least 1/8 inch (3.2 mm) high and shall be molded, die-stamped, paint-stenciled, stamped or etched on metal, or indelibly stamped on pressure sensitive labels secured by adhesive. Pressure sensitive labels secured by adhesive shall comply with the applicable portions of the Standard for Marking and Labeling Systems, UL 969.

Exception: The markings specified in 71.7, 71.10, and 71.12 are not prohibited from being provided as cord tags that are formed as described, and comply with the requirements, in Cord Tags, Section 72, and are:

a) Permanently affixed to the power-supply cord;

b) Located not more than 6 inches (152.4 mm) from the pump housing;

c) Made of substantial material such as cloth, plastic, or the equivalent that provides the required mechanical strength and prevents easy removal; and

d) Sized so that the required markings are legible, and all exposed surfaces have a clear plastic overlay, or the equivalent, to protect the markings.

71.4 The tags described in the Exception to 71.3 shall be in either of the following forms:

a) A flag-type tag having a hole to permit securement to the power-supply cord by a plastic strip or equivalent means. The strap shall not be removable without cutting.

b) A flag-type tag with an adhesive back. The tag shall be wrapped tightly once around and shall adhere to the power-supply cord. The ends of the tag shall adhere to each other and project as a flag. The required markings shall be positioned on the projecting flag portion of the tag.

71.5 All markings specified as being ″visible after installation″ shall be visible from the service access. See 79.5.

71.6 When a unit is manufactured at more than one factory, each finished unit shall have a distinctive marking, which may be in code, by which it can be identified as the product of a particular factory.

71.7 Each unit shall be plainly marked with the following or the equivalent: ″Connect only to a circuit that is protected by a ground-fault circuit-interrupter (GFCI).″

71.8 A wiring diagram shall be attached to the unit unless field-wiring connections are obvious.

71.9 A paper sticker glued or shellacked or both to an accessible cover is considered to be attached to the unit in accordance with the requirement in 71.8.

71.10 A unit intended to be protected by a branch circuit fuse less than the maximum rating of the branch circuit fuse to which the unit may be connected shall be marked to indicate the maximum current rating of the branch circuit fuse for which the unit has been investigated and determined to be acceptable.

71.11 The following marking or the equivalent, as applicable, shall appear in the field wiring compartment next to the supply conductor terminals of a unit intended for permanent electrical connection: ″Use copper conductors only,″ ″Use aluminum conductors only,″ or ″Use aluminum or copper conductors.″ This marking shall be independent of any marking on the terminal connectors, and it shall be visible during and after installation of the unit. This marking does not apply to terminals intended for the connection of grounding or bonding conductors.

71.12 A unit as specified in 49.1 that will not start and operate as intended when connected to a circuit protected by an ordinary (non-time-delay) fuse shall be plainly and permanently marked with the following or the equivalent: ″Use only time-delay fuses.″

71.13 Each connector intended for an optional accessory shall be marked to identify the intended accessory.

71.14 If more than one disconnect switch is required to disconnect all power to a unit, the unit shall be marked where readily visible to service personnel prior to disconnecting the main supply for the unit with the word ″CAUTION″ and the following or the equivalent: ″Risk of Electric Shock – _____ disconnect switches are required to de-energize the unit before servicing.″ The blank is filled in with the number of disconnect switches needed to de-energize the unit, two or three.

71.15 If any point within a terminal box or field wiring compartment of a permanently connected unit attains a temperature exceeding 60°C (140°F) during the Temperature Test, Section 51, the unit shall be permanently marked with the following or the equivalent: ″For supply connection, use wires sized on the basis of 60°C ampacity and rated minimum ____°C (___°F).″ The temperature value shall be in accordance with the values specified in Table 71.1. This statement shall be located at or near the point where the supply connections are to be made, and shall be clearly visible both during and after installation of the unit.

Table 71.1
Terminal box marking

Maximum temperature attained in terminal box or compartment during temperature test, °C	(°F)	Temperature marking, °C	(°F)
61 – 75	(142 – 167)	75	(167)
76 – 90	(169 – 194)	90	(194)

71.16 A double-insulated component shall be plainly and permanently marked with the words ″Double Insulated″ or ″Double Insulation″ and ″CAUTION – For continued protection against possible electric shock use only identical replacement parts when servicing.″ These markings shall be located so that they are clearly visible after installation.

71.17 The double-insulation symbol – a square within a square – may be used in addition to, but not in place of, the words ″Double Insulated″ or ″Double Insulation.″

71.18 Each unit shall be plainly and permanently marked to identify the factory-installed components of the unit. These components include pumps, controls, heaters, luminaires, and supply cords. This marking shall be visible from the recommended access specified in the installation instructions.

71.19 Hydromassage bathtubs not factory-configured for a field-installed heater shall be plainly and permanently marked "Not Suitable for Field-Installed Heater". This marking shall be visible from the recommended access specified in the installation instructions.

72 Cord Tags

72.1 A tag used for the cautionary markings described in the Exception to 71.3 and 71.4 shall comply with the requirements:

a) In 72.2 – 72.5; and

b) For permanence and legibility in the Standard for Marking and Labeling Systems, UL 969.

72.2 Three as-received samples and six samples of the tag that have been subjected to the conditioning specified in 72.4, three for each conditioning, shall be subjected to the test described in 72.5. After testing, the samples shall comply with the following requirements:

a) The tag shall not tear for more than 1/16 inch (1.6 mm) at any point;

b) The tag shall not separate from the power-supply cord;

c) The tag shall not slip or move along the length of the power-supply cord more than 1/2 inch (12.7 mm);

d) There shall be no permanent shrinkage, deformation, cracking, or any other condition that will render the marking on the tag illegible; and

e) Overlamination shall remain in place and not be torn or otherwise damaged. The printing shall remain legible.

72.3 Each sample is to consist of a length of power-supply cord. The tag is to be affixed to the power-supply cord in the intended manner. When tags are applied by an adhesive, tests are to be conducted no sooner than 24 hours after application of the tag.

72.4 The conditioning required by 72.2 is to consist of the following:

a) The samples are to be conditioned for 24 hours in an air-circulating oven maintained at a uniform temperature of 87.0 ±1.0°C (188.6 ±1.8°F). Following removal from the oven, the samples are to remain at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F) and a relative humidity of 50 ±5 percent for 30 minutes before testing.

b) The samples are to be conditioned for 72 hours in a humidity of 85 ±5 percent at 32.0 ±2.0°C (89.6 ±3.6°F). The samples are to be tested within 1 minute after the conditioning.

72.5 The power-supply cord, with the attachment plug pointing up, is to be held tautly in a vertical plane. A force of 5 pounds (22.3 N) is to be applied to the uppermost corner of the tag farthest from the power-supply cord, within 1/4 inch (6.4 mm) of the vertical edge of the tag. The force is to be applied vertically downward in a direction parallel to the major axis of the cord and maintained for 1 minute. Results shall comply with the requirements in 72.2.

73 Hydromassage Bathtubs Configured for Field-Installed Heaters

73.1 The requirements in 73.2 – 73.4 are to be used in conjunction with Markings, General, Section 71. The requirements in 73.2 – 73.4 supersede corresponding requirements in Section 71.

73.2 A hydromassage bathtub configured for a heater intended for field installation shall be legibly and permanently marked with: ″Suitable for Field-Installed Heater Accessory″ and ″Use Only Field-Installed Heaters Marked for Use With This Bathtub″. This marking shall be visible after installation. The marking is not prohibited from additionally specifying the model number(s) of suitable heaters. A field-installed heater utilizing a proprietary fitting shall not be prohibited from referencing a specific factory-installed fitting instead of bathtub.

73.3 A hydromassage bathtub configured for a heater intended for field installation that requires a separate source of supply shall be marked with the word ″CAUTION″ and the following or the equivalent: ″Risk of Electric Shock – Second supply source if field-installed heater is installed. Disconnect all sources before servicing″. The marking shall be visible, legible, and permanent after installation. See 71.3.

73.4 The electrical rating of a hydromassage bathtub configured for a heater intended for field installation shall indicate the rating if the field-installed heater is installed.

74 Field-Installed Heaters

74.1 The requirements in 74.2 – 74.5 are to be used in conjunction with Markings, General, Section 71, and Cord Tags, Section 72. The requirements in 74.2 – 74.5 supersede corresponding requirements in Section 71.

74.2 A heater intended for field installation shall be provided with a cautionary statement specifying the hydromassage bathtubs that are configured to accept the heater. The cautionary statement shall be provided in one of the following (or equivalent) forms:

a) The word ″CAUTION″ and the following (or equivalent) wording: ″To reduce the risk of fire, electric shock, and/or injury to persons, install only in the hydromassage bathtub specified on the compatibility sheet packaged with this heater″. The marking shall be legibly and permanently marked on the heater (see 71.3). The compatibility sheet shall detail the model numbers of the hydromassage bathtubs that are intended to accept the heater. The marking is not prohibited from additionally including the following or equivalent wording: ″For the latest list of compatible hydromassage bathtubs, contact ____″, where the blank contains the manufacturer's name, telephone and/or fax number(s) and/or email address, and/or internet web page address(es). The marking containing the list of compatible hydromassage bathtubs shall be provided either on or in the heater shipping carton, and is not prohibited from being provided/displayed on the heater.

b) The heater intended for field installation, and the carton in which the heater is contained, shall be marked with the word ″CAUTION″ and the following (or equivalent wording): ″To reduce the risk of fire, electric shock, and/or injury to persons, install only in the following hydromassage bathtub model(s): ____ manufactured by ____.″

c) A heater intended for field installation in a bathtub that is provided with proprietary factory-installed fittings intended to accept the heater shall be marked with the word ″CAUTION″ and the following or equivalent wording: ″To reduce the risk of fire, electric shock, and/or injury to persons, install only in the hydromassage bathtub factory-configured with fitting model: ____.″ The factory-installed fitting shall be marked with the corresponding model number.

The marking shall be legible and permanent (see 71.3).

74.3 A heater intended for field installation shall be provided with the specified instructions pertaining to a risk of fire, electric shock, and/or injury to persons in accordance with 77.3.

74.4 A heater intended for field installation shall be provided with operating instructions in accordance with 78.1 – 78.5.

74.5 Installation instructions shall be packed with a heater intended for field installation and shall provide sufficient information to enable the heater to be installed in the hydromassage bathtub as intended.

75 Direct Plug-In Controls

75.1 Direct plug-in controllers shall be plainly marked where visible after being installed in the intended manner with the word ″CAUTION″ and the following or equivalent: ″For use only for controlling ____″ where the blank is filled in with the intended load. The word ″CAUTION″ shall be in minimum 1/8-inch (3.2-mm) high letters and the remainder of the marking shall be in minimum 1/16-inch (1.6-mm) high letters.

75.2 Direct plug-in controllers shall be marked – on the controller, a marking tag, an instruction sheet packed with the controller, or the installation instructions of the bathtub – with the word ″CAUTION″ and the following mounting instructions or the equivalent:

a) ″To reduce the risk of electric shock - Disconnect power to the receptacle before installing or removing the controller. When removing the receptacle cover screw, cover may fall across plug pins or receptacle may become displaced″;

b) ″Use only with duplex receptacle having center screw″; and

c) ″Secure controller in place by receptacle cover screw″.

INSTRUCTIONS

76 General

76.1 Each unit shall be provided with legible installation, operating, and user-maintenance instructions, and instructions pertaining to a risk of fire, electric shock, or injury to persons associated with the use of the unit.

76.2 Installation and operating instructions shall be provided for each accessory provided with the unit.

76.3 The instructions described in 76.1 shall be:

a) In separate manuals; or

b) Combined in one or more manuals provided the instructions pertaining to a risk of fire, electric shock, or injury to persons are separated in format and emphasized to distinguish them from the remainder of the text.

76.3.1 The following instructions shall be provided as printed material:

a) The instructions pertaining to a risk of fire, electric shock, or injury to persons as required by Section 77; and

b) A minimum set of installation and operating instructions, such as a quick start guide, that includes the required warning instructions required by Sections 78 and 79.

76.3.2 All other instructions may be provided in electronic read-only media format only, such as a DVD, website, flash drive or CD-ROM. If any electronic media instructions are provided, the instructions and warning statements required by Section 76.1 shall also be included within the electronic media instructions.

76.3.3 The printed instructions material referenced in Section 76.3 shall contain detailed instructions of how to obtain a printed copy of the material contained in electronic format.

76.4 An illustration may be used with a required instruction to clarify the intent but shall not replace the written instruction.

76.5 The height of the lettering in the text and illustrations of the important safety instructions shall be as follows:

a) Uppercase letters shall be not less than 1/12 inch (2.1 mm) high;

b) Lowercase letters shall be not less than 1/16 inch (1.6 mm) high; and

c) The phrases ″IMPORTANT SAFETY INSTRUCTIONS,″ ″READ AND FOLLOW ALL INSTRUCTIONS,″ and ″SAVE THESE INSTRUCTIONS″ shall be in letters not less than 3/16 inch (4.8 mm) high.

76.6 The following items shall be entirely in uppercase letters or shall be emphasized to distinguish them from the rest of the text:

a) The headings for the installation, operating, and user-maintenance instructions;

b) The heading for the instructions pertaining to a risk of fire, electric shock, or injury to persons; and

c) The opening and closing statements of the instructions specified in 77.3 – ″IMPORTANT SAFETY INSTRUCTIONS″ and ″SAVE THESE INSTRUCTIONS,″ or the equivalent.

76.7 Unless otherwise indicated, the text of the instructions in 77.1 and 77.3 shall be in the words specified or words that are equivalent, clear, and understandable. No substitute shall be used for ″WARNING″ or ″DANGER.″

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77 Instructions Pertaining to a Risk of Fire, Electric Shock, or Injury to Persons

77.1 Instructions pertaining to a risk of fire, electric shock, or injury to persons shall warn the user of reasonably foreseeable risks and state the precautions that shall be taken to reduce such risks.

77.2 The items in the list in 77.3 may be numbered and other instructions pertaining to a risk of fire, electric shock, or injury to persons that the manufacturer believes are needed may be included.

77.3 The instructions pertaining to a risk of fire, electric shock, or injury to persons shall include those items in the following list that are applicable to the unit. The statement ″INSTRUCTIONS PERTAINING TO A RISK OF FIRE, ELECTRIC SHOCK, OR INJURY TO PERSONS″ or the equivalent shall precede the list, and the statement ″SAVE THESE INSTRUCTIONS″ or the equivalent shall either precede or follow the list. The word ″WARNING″ shall be entirely in uppercase letters or shall be emphasized to distinguish it from the remainder of the text. Wording in parentheses is explanatory.

INSTRUCTIONS PERTAINING TO A RISK OF FIRE, ELECTRIC SHOCK, OR INJURY TO PERSONS

WARNING – When using this unit, basic precautions should always be followed, including the following:

1. READ AND FOLLOW ALL INSTRUCTIONS.

2. DANGER: To reduce the risk of injury, do not permit children to use this unit unless they are closely supervised at all times.

3. Use this unit only for its intended use as described in this manual. Do not use attachments not recommended by the manufacturer.

4. Never drop or insert any object into any opening.

5. Do not operate this unit without the guard over the suction fitting.

6. The unit must be connected only to a supply circuit that is protected by a ground-fault circuit-interrupter (GFCI). Such a GFCI should be provided by the installer and should be tested on a routine basis. To test the GFCI, push the test button. The GFCI should interrupt power. Push the reset button. Power should be restored. If the GFCI fails to operate in this manner, the GFCI is defective. If the GFCI interrupts power to the bathtub without the test button being pushed, a ground current is flowing, indicating the possibility of an electric shock. Do not use this hydromassage bathtub. Disconnect the hydromassage bathtub and have the problem corrected by a qualified service representative before using.

7. (For permanently connected units) A green-colored terminal (or a wire connector marked ″G,″ ″GR,″ ″Ground,″ or ″Grounding″) is provided within the terminal compartment. To reduce the risk of electric shock, connect this terminal or connector to the grounding terminal of your electric service or supply panel with a conductor equivalent in size to the circuit conductors supplying this equipment.

8. SAVE THESE INSTRUCTIONS.