UL 1563

STANDARD FOR SAFETY

Electric Spas, Equipment Assemblies, and Associated Equipment

UL Standard for Safety for Electric Spas, Equipment Assemblies, and Associated Equipment, UL 1563

Sixth Edition, Dated July 16, 2009

Summary of Topics

This revision of ANSI/UL 1563 dated September 10, 2020 includes the withdrawal and replacement of UL 508C with UL 61800-5-1; 29.2.1 and 32.1.2.

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated July 3, 2020.

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

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INTRODUCTION

1 Scope

1.1 These requirements apply to self-contained spas. They also apply to field-installed equipment assemblies, blowers, and controls for use with field-installed hot tubs, swimming pools, and non-self-contained spas. These products are for household or commercial use, indoors, outdoors, or both. All equipment is intended for installation and use in accordance with Article 680 of the National Electrical Code, NFPA 70.

1.2 These requirements also apply to field-installed accessories that have been investigated with the basic product.

1.3 These requirements do not apply to products covered by the following UL Standards:

a) Underwater Luminaires and Submersible Junction Boxes, UL 676;

b) Swimming Pool Pumps, Filters, and Chlorinators, UL 1081;

c) Electric Water Heaters for Pools and Tubs, UL 1261;

d) Personal Hygiene and Health Care Appliances, UL 1431 (professional hydrotherapy equipment – whirlpool bathtubs); and

e) Hydromassage Bathtubs, UL 1795.

2 Components

Section 2 revised and relocated as Section 7A.1

3 Units of Measurement

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

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

4 Undated References

4.1 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.

5 Glossary

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

5.2 ACCESSIBLE PART – A part located so that it can be contacted by a person.

5.3 ACCESSIBLE TO THE OCCUPANT – Any surface or component within 5 feet (1.52 m) of the tub water, measured by any convenient method such as a measuring tape or a 5-foot flexible wire, cord, or string. The distance shall be measured with the service door closed and shall be the shortest path without piercing a permanent barrier such as the tub or skirt of a spa or the service door.

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

5.5 *Revised and relocated as 5.14.1*

5.6 BONDING TERMINAL – A pressure wire connector secured to the enclosure in which the power supply conductors are terminated, for the connection of a bonding conductor.

5.7 CLASS 2 CIRCUIT – A secondary circuit with an open circuit potential of not more than 30 volts rms (42.4 volts peak) supplied by a Class 2 transformer, or by a transformer and fixed impedance that together comply with all performance requirements for Class 2 transformers in the Standard for Low Voltage Transformers: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers: Class 2 and Class 3 Transformers, UL 5085-3.

5.8 COMMON BONDING GRID – A common bonding grid may be a copper grounding loop, metal reinforcing rods in a concrete or tile supporting pad, or a network of other local groundable metal that local inspection authorities evaluate to be in compliance with Section 680-26(B) of the National Electrical Code, ANSI/NFPA 70.

5.9 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.

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

5.9.2 CONTROL, AUXILIARY – A device that provides a functional utility but is not relied on as an operational or protective control. The failure of an auxiliary control generally does not cause the operation of a protective control. An example of an auxiliary is one that controls the “on/off” state of spa lighting.

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

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

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

5.9.6 CONTROL, TYPE 2 ACTION – The actuation of an automatic control (see 5.9.1) for which the manufacturing deviation and the drift of its operating value, operating time, or operating sequence have been declared and tested under the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1.

5.9.7 CONTROL, TYPE 2.D.H ACTION – This action is applicable to manual controls (see 5.9.3). The automatic action (i.e. tripping of the control) is independent of the manipulation or position of the manual reset/adjustment mechanism. The manipulation of the manual adjustment means will not allow for the reverse operation (resetting of a "tripped" control), even momentarily, while the excess or fault condition persists. This action is also referred to as trip-free action. The action of the control is such that the reverse operation (resetting) is possible if the manual reset mechanism is held in the reset position – i.e. the control will function as an automatic control if the reset button is held in the reset position. The control shall

not reset automatically at any temperature above -35°C (-31°F) with the reset mechanism in the normal position.

5.9.8 CONTROL, TYPE 2.D.J ACTION – This action is applicable to manual controls (see 5.9.3). The automatic action (i.e. tripping of the control) is independent of the manipulation or position of the manual reset/adjustment mechanism. The manipulation of the manual adjustment means will not allow for the reverse operation (resetting of the control), even momentarily, while the excess or fault condition persists. This action is also referred to as trip-free action.

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

5.11 CONVERTIBLE UNIT – A spa or equipment assembly that is shipped from the factory with a power supply cord and that is intended for optional field conversion to a permanently-wired configuration.

5.12 DISCONNECTING MEANS – A suitably rated switch or circuit breaker that opens all ungrounded circuit conductors and that is readily accessible to the user of the unit.

5.13 DRY-FIRE – Fire resulting from dry operation of heating element intended to be continuously immersed.

5.14 ENCLOSURE – That part of a unit that renders inaccessible any part that may present a risk of electric shock, prevents emission of flame or molten material, or prevents unintentional contact with internal parts that may involve a risk of injury. Some examples are tub materials, skirting materials, electrical boxes, and barriers.

5.14.1 EQUIPMENT ASSEMBLY – A factory-assembled grouping of electrical components used to provide heating, filtering, aeration, or both filtering and aeration of water circulated in a field-supplied tub. An assembly can be either permanently connected or cord-and-plug connected.

5.15 GROUNDING TERMINAL – A designated pressure wire connector located within the field wiring compartment to terminate the equipment grounding conductor of the supply circuit.

5.16 HEATING ELEMENT – An unbroken length of resistance material used to electrically generate heat.

5.16.1 HOT TUB – See SPA, 5.28.

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

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

5.19 LEAKAGE CURRENT COLLECTOR – Metal in the water-circulating system intended to provide a low-impedance path for leakage currents to ground.

5.20 OPEN MOTOR – A motor having ventilating openings that permit passage of external cooling air over and around the windings of the motor.

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

5.22 RISK OF ELECTRIC SHOCK – A risk of electric shock is considered to exist whenever the available current exceeds the limits specified in Table 5.1 when measured as described in the Available Current Test, Section 44. Other current waveforms than specified in Table 5.1 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 5.1
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
Spa water and ground	0.5	2.0
Any point accessible to the spa occupant and ground	0.5	2.0
Any point on the spa control and ground[a]	0.5	2.0
Any two points on the spa 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.		

5.23 RISK OF FIRE – A risk of fire is considered to exist when the power limitations of a Class 2 circuit as defined in the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3, are exceeded.

5.24 SAFETY CIRCUIT – A circuit that is relied upon to reduce the risk of fire, electric shock, unintentional contact with moving parts, or other casualty hazard (such as hyperthermia). Examples include, but are not limited to:

a) An interlock circuit used to prevent the risk of electric shock and/or injury to persons;

b) A circuit which limits current to accessible parts;

c) A circuit which limits the wattage to a limited-energy circuit;

d) A temperature-limiting control;

e) A temperature-regulating control; and

f) A dry-fire control.

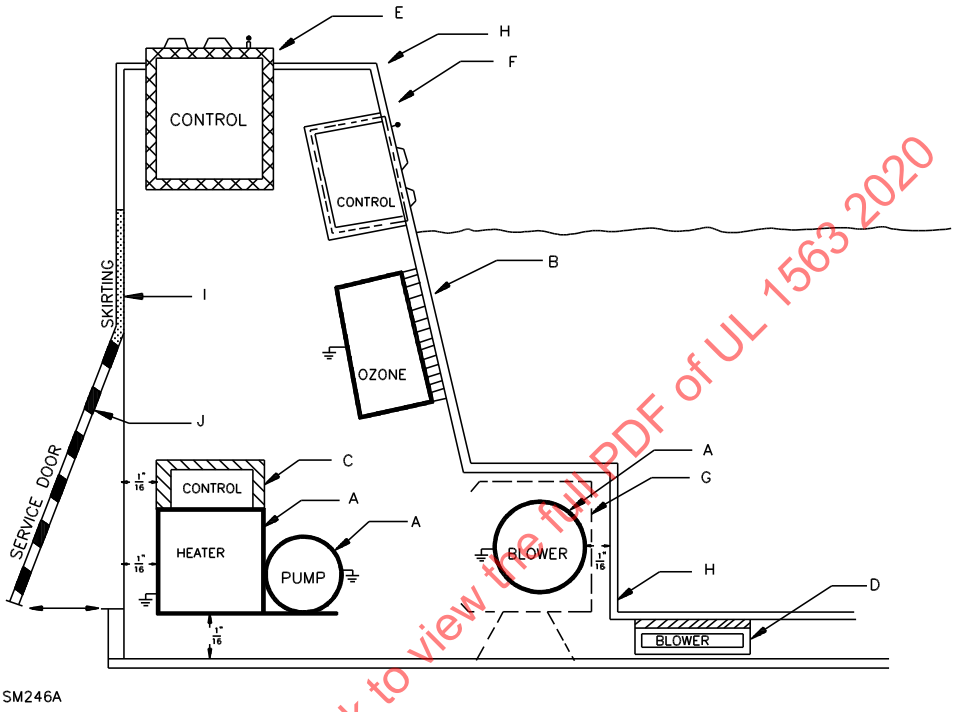
5.24.1 SAFETY CRITICAL FUNCTION – Control, protection and monitoring functions which are being relied upon to reduce the risk of fire, electric shock or casualty hazards.

5.25 SECONDARY CIRCUIT – A circuit supplied from an output winding of an isolating transformer.

5.26 SELF-CONTAINED SPA – A portable spa in which all control, water-heating, and water-circulating equipment is an integral part of the product. Self-contained spas may be permanently wired or cord connected. See Figure 5.1 for an example of a self-contained spa.

Figure 5.1

Example of self-contained spa



A – Grounded metal with spacings to material accessible to the occupant (see 12.4).

B – Grounded metal with insulation in lieu of spacings to material accessible to the occupant (see 12.4).

C – Nonmetallic enclosure of live parts[a] with spacings to material accessible to the occupant (see 8.3.3 and 12.5).

D – Nonmetallic enclosure of live parts[a] with insulation in lieu of spacings to material accessible to the occupant (see 8.3.3 and 12.5).

E – Nonmetallic enclosure of live parts[a] accessible to the occupant (see 8.3.3 and 12.6).

F – Nonmetallic enclosure of live parts[b] accessible to the occupant (see 8.3.3 and 12.7).

G – Alcove/shroud used to support components (see 8.3.5).

H – Tub material (see 8.3.4).

I – Skirting (see 8.3.1, 8.3.2, and 8.3.4).

J – Service door (see 8.1.5, 8.3.1, 8.3.2, and 8.3.4).

[a] Live parts that present a risk of electric shock (see 5.22).

[b] Live parts that do not present a risk of electric shock.

5.27 SKIMMER – A suction opening intended to remove floating debris from the water surface and to be installed where part of the water intake opening is open to atmospheric pressure.

5.28 SPA – A product intended for the immersion of persons in heated water circulated in a closed system, and not intended to be drained and filled with each use. A spa usually includes a filter, a heater (electric, solar, or gas), a pump or pumps, and a control, and may also include other equipment such as lights, blowers, and water sanitizing equipment.

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

5.30 TOTALLY ENCLOSED MOTOR – A motor that is enclosed to prevent the free exchange of air between the inside and outside of the enclosure but not necessarily sufficiently enclosed to be airtight.

5.31 UNIT – A collective term used to designate all products covered by this standard; such as a self-contained spa, equipment assembly, blower, and control.

5.32 *Deleted*

6 Accessories

6.1 An accessory intended for field installation shall comply with the applicable requirements in this standard and shall be constructed so that it can be installed and used without the need for altering wiring, enclosure, or other features of the basic unit that are relied upon to reduce the risk of fire, electric shock, or injury to persons.

6A Safety Critical Functions

6A.1 Any function involved in the control, protection, and monitoring of safety-related attributes of a pump 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.

6A.2 Electronic circuits that manage a Safety Critical Function shall be:

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

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

6A.3 Electronic circuits managing Safety Critical Functions shall comply with:

a) Supplement SB; or

b) the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1 and it's Part 2's as specified in this standard. The function shall be considered Class B. When utilizing UL 60730-1, surge protective devices are defeated for the EMC immunity testing unless they are provided with spark gaps (gas tube surge suppressors); or

c) The requirements in Appendix B for circuits providing the Safety Critical heater functions relating to the risk of hyperthermia, scalding and loss of water flow (dry-fire protection).

6A.4 Functions specified in Table 6A.1 represent the common safety critical circuit functions of spas. It is not intended to represent all possible Safety Critical Functions.

Table 6A.1
Safety Critical Functions

Function[a]	Hazard	Location of parameters and tests
Motor running overload protection	Risk of fire or electric shock	Section 29.2
Motor locked rotor protection	Risk of fire or electric shock	Section 29.2
Motor short circuit protection	Risk of fire or electric shock	Section 29.2
Temperature regulating control	Hyperthermia	Section 35
Temperature limiting control	Scalding	Section 36
Water-Flow Controls (dry-fire protection)	Risk of fire, electric shock, or scalding	37.4

[a] Functions specified in the table represent the common safety critical circuit functions of spas. 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 product 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.

CONSTRUCTION

7 General

7.1 A unit shall be evaluated for both indoor and outdoor use unless marked "For Indoor Use Only" or "For Outdoor Use Only."

7.2 A unit that uses a gas heater shall be marked "For Outdoor Use Only" unless an investigation shows that the unit vents heat and exhaust in a manner that complies with the applicable building code.

7A Component Specifications

7A.1 General

7A.1.1 Except as indicated in 7A.1.2, a component of a product covered by this standard shall comply with the requirements for that component as indicated in this Section.

7A.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.

7A.1.3 A component shall be used in accordance with its rating established for the intended conditions of use.

7A.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.

7A.1.5 Components shall be suitable for the intended use and installation environment. This suitability shall assume the following installation parameters.

a) Outdoor, Pollution Degree III installations.

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

7A.1.6 Components not anticipated by the requirements of this Standard, not specifically covered by a component standard of Component Specifications, Section 7A, 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.

7A.2 Quick-connect wire connectors

7A.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.

7A.2.2 Quick-connect type wire connectors shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310.

7A.3 Terminal blocks

7A.3.1 Terminal blocks shall comply with:

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

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

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

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

7A.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.

7A.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.

7A.4 Wire connectors

7A.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.

7A.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.

7A.5 Button or coin cell batteries of lithium technologies

Relocated to Clause 37.9.

8 Frame and Enclosure

8.1 General

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

8.1.2 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 increasing the 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.

8.1.3 Unless marked "For Indoor Use Only," a unit shall be subjected to the simulated rain test described in 54.4.1. A switch, circuit breaker, fuseholder, or similar device and any opening associated with an operating handle shall be shielded from rain.

8.1.4 The shielding specified in 8.1.3 shall be formed of material intended for use as an enclosure, as described in 8.2.1 – 8.3.1, and shall not be detachable from the enclosure without the use of tools.

8.1.5 A service door in a spa shall be held in the closed position by a positive means, such as:

a) A hinged door that is held closed by a magnetic or mechanical latch;

b) A sliding type door; or

c) A non-hinged or non-sliding door that is held in place by a magnetic or mechanical latch or screws complying with 9.6. Also see 39.8.

Exception: This requirement does not apply to a service door providing access only to nonelectrical equipment or to controls that comply with the requirement in 12.6 or 12.8.

8.2 Metal enclosures

8.2.1 The outer enclosure of a unit intended for outdoor use, if of sheet metal, shall not be less than 0.032 inch (0.81 mm) thick if uncoated steel, not less than 0.034 inch (0.86 mm) thick if galvanized steel, and not less than 0.045 inch (1.14 mm) thick if nonferrous. The enclosure shall also comply with Resistance to Corrosion, Section 13.

8.2.2 An enclosure of sheet metal, other than that covered in 8.2.1, shall be evaluated with regard to its size, shape, and thickness, considering the intended use of the complete unit. Sheet steel shall have a thickness of not less than 0.026 inch (0.66 mm) if uncoated when measured, or 0.029 inch (0.74 mm) if galvanized. Nonferrous sheet metal shall have a thickness of not less than 0.036 inch (0.91 mm).

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.

8.2.3 Cast metal portions of an enclosure shall be no thinner than indicated in Table 8.1.

Table 8.1
Minimum thicknesses of enclosure metal

Metal	At small, flat unreinforced surfaces and at surfaces that are reinforced by curving, ribbing, or the like (or are otherwise of a shape or size or both) to provide physical strength,		At relatively large unreinforced flat surfaces,	
	inch	(mm)	inch	(mm)
Die-cast	3/64	1.2	5/64	2.0
Cast malleable iron	1/16	1.6	3/32	2.4
Other cast metal	3/32	2.4	1/8	3.2

8.3 Nonmetallic enclosures

8.3.1 Among the factors taken into consideration when evaluating the acceptability of a nonmetallic material, other than a polymeric material, when used to enclose grounded metal or live parts are:

a) Mechanical strength;

b) Resistance to impact;

c) Moisture absorptive properties;

d) Combustibility; and

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

8.3.2 Wooden skirting material used as a barrier to grounded metal shall be minimum 1/4 inch (6.4 mm) thick.

Exception: Wood that is less than 1/4 inch thick may be used as a barrier to grounded metal if the material complies with the impact test described in 56.1. The test may also be used whenever referee tests for the integrity of a material are necessary.

8.3.3 A polymeric material used as the enclosure of live parts, or as a barrier in lieu of spacings shall comply with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, based on the application and, if intended to be exposed to sunlight, it shall also be investigated for resistance to the ultraviolet light exposure requirements as specified in UL 746C, except flammability after conditioning is not considered.

8.3.3.1 The polymeric housing of a component is not considered to be an appliance enclosure unless this part is the sole insulation (excluding air) between a live part and an external surface of the appliance.

8.3.4 A polymeric material used as a barrier to grounded metal (such as the tub and skirting material) shall:

a) Be resistant to impact as specified in the Test for Resistance to Impact, Section 56; and

b) When used outdoors, be resistant to the ultraviolet light exposure requirements as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, except that flammability after conditioning is not considered.

Exception No. 1: A polymeric material that is minimum 1/4 inch thick need not be subjected to the Test for Resistance to Impact.

Exception No. 2: Polymeric spa skirting is not required to comply with the requirements in 8.3.4 when:

a) It is used for aesthetic purposes only and is not relied upon to serve as an enclosure of live parts, a barrier to grounded metal, or provide protection from elements of outdoor use, such as water exposure. Examples include use of polymeric materials with wood backing (or other suitable material) where the wood (or other suitable material) serves as the enclosure or the barrier to provide the necessary weather and accessibility protection; or

b) An alcove, cowling, shroud, or similar structure is used that completely encloses all electrical components under the spa skirt; or

c) All components such as pumps, blowers, spa controls, interconnecting cords, and similar parts have been evaluated for outdoor use and are not accessible to the tub occupant.

8.3.5 An alcove, cowling, shroud, or similar structure used under the skirt of a spa to support components or as a supporting framework shall have a minimum flame rating of HB or HBF. The material shall be suitable for the temperatures to which it is subjected to under conditions of normal use. Additional factors taken into consideration when evaluating its acceptability include but are not limited to:

a) Mechanical strength and

b) Resistance to impact.

8.3.6 The polymeric materials specified in 8.3.3 and 8.3.4, when molded or fabricated by a source other than the manufacturer of the unit, shall comply with the requirements in the Standard for Polymeric Materials – Fabricated Parts, UL 746D.

8.3.7 A polymeric enclosure, barrier, or similar part enclosing or protecting a component which presents a risk of electric shock (as defined in 5.22) and/or injury to persons due to its location or intended use under normal or abnormal use, or that may be used as a seat, step, or support structure facilitating entry or exit from the spa, shall comply with the applicable structural integrity tests as specified in Structural Integrity Tests, Section 62.

Exception: Small parts such as spa side controls or other similar parts that are unlikely to be subjected to the loading effects anticipated by the structural integrity tests shall be subjected to the Test for Resistance to Impact, Section 56.

8.4 Drainage

8.4.1 An enclosure shall be constructed so that there will be no reduction in the effectiveness of the electrical insulation due to breakdown of water connections or shaft seals, flooding onto a mounting surface or within the outer enclosure, or rupture of a boot, diaphragm, shaft seal, or the like, as determined in the Water Exposure Test, Section 54.

8.4.2 An enclosure of an outdoor unit containing an electrical component, other than for a motor having a sealed housing, shall have provision for drainage when there is a knockout or unthreaded opening in the enclosure, or when there is risk of condensation accumulation.

8.4.3 The lowest portion of any live part in a hot tub or spa shall be at least 4 inches (102 mm) above the surface on which the unit will ultimately be installed.

8.4.4 An enclosure shall be provided with means for drainage so that there will be no submersion of components as determined in the Water Exposure Test, Section 54.

8.5 Mounting pads or holes

8.5.1 Mounting pads or holes for wall mounting of an assembly shall be external to the enclosure unless the assembly is marked for indoor use only, as indicated in 70.1.

8.5.2 A unit intended for permanent connection shall be provided with means for mounting or support. Fittings necessary for proper mounting, such as brackets, hangers, or the like, shall be furnished with the unit.

8.6 Barriers

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

Exception: A permanently connected unit not intended for mounting on combustible surfaces may have an open bottom if it is marked in accordance with 72.2.2 or 72.3.2, as applicable.

8.6.2 The requirement in 8.6.1 necessitates use of a barrier of combustion-resistant material:

a) Under a motor unless:

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

2) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the 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 reduce the risk of 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.

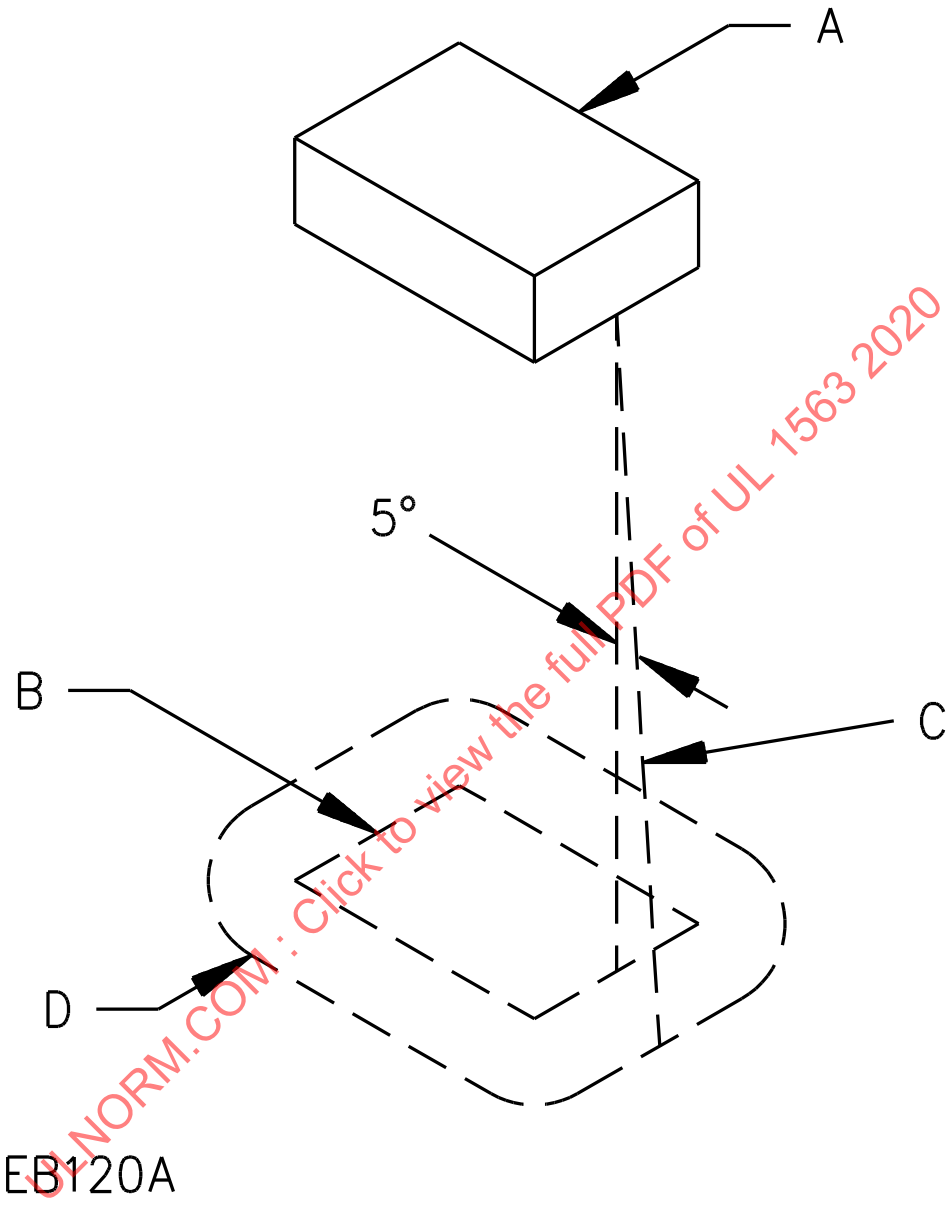
8.6.3 The requirement in 8.6.1 necessitates that a switch, transformer, relay, solenoid, or the like be individually and completely enclosed other than at terminals, unless it can be shown that malfunction of the component would not result in a risk of fire, or unless there are no openings in the bottom of the enclosure. An opening in the bottom of the enclosure shall not be located directly below field- or factory-made splices or overload or overcurrent protective devices.

8.6.4 The barrier mentioned in 8.6.2 shall be horizontal, shall be located as indicated in Figure 8.1, and shall not have an area less than that described in the figure. Openings for drainage, ventilation, or the like

may be employed in the barrier, provided such openings would not increase the risk of molten metal, burning insulation, or the like falling 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) So oriented that the area traced out on a horizontal plane is maximum.

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

8.6.5 The barrier specified in 8.6.2 shall have a minimum flammability rating of 5VA in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

8.7 Ventilating openings

8.7.1 An opening in an enclosure for ventilation or for the dissipation of heated air shall be provided with one or more baffles to reduce the risk of emission of flame, molten metal, or burning insulation.

Exception No. 1: An opening in the bottom of the enclosure need not be provided with baffles unless otherwise required by 8.6.1 – 8.6.4.

Exception No. 2: In a compartment other than one that houses an overload or overcurrent protective device, the baffles may be omitted if the opening is in a vertical wall and is a maximum of 3/8 inch (9.5 mm) wide.

9 Mechanical Assembly

9.1 A unit shall be assembled so that it will not be adversely affected by the vibration of operation. Brush caps shall be tightly threaded or otherwise designed so as not to loosen.

9.2 A switch, a lampholder, an attachment plug receptacle, a motor attachment plug, or similar component shall be mounted securely and shall be prevented from turning.

Exception No. 1: The requirement that a switch be prevented from turning may be waived if all four of the following conditions are met.

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 subjected to forces that tend to turn the switch during operation of the switch),

b) Means of mounting the switch make it unlikely that operation of the switch will loosen it,

c) The spacings are not reduced below the minimum required values if the switch rotates, and

d) Operation of the switch is to be by mechanical means rather than contact by persons.

Exception No. 2: A lampholder of a type in which the lamp cannot be replaced (such as a neon pilot or indicator lamp in which the lamp is sealed in a nonremovable jewel) need not be prevented from turning if rotation cannot reduce spacings below the minimum acceptable values or adversely affect water resistance of outdoor units.

9.3 The means for preventing the turning mentioned in 9.2 is to consist of more than friction between surfaces – for example, a lock washer may be used as means for preventing a small stem-mounted switch or other device having a single-hole mounting means from turning.

9.4 Each uninsulated live part shall be secured to the base or mounting surface so that it will not turn or shift in position if such motion may result in a reduction of spacings below the minimum values indicated in Spacings, Section 25.

9.5 Tin-lead solder shall not be used for the fastening of seams or the assembly of parts.

9.6 Screws that attach a cover, door, or other part that is removed to operate the unit or to install field wiring shall be retained by at least two full threads into metal.

Exception: Other materials using other means of securement may be used if determined to serve the purpose.

9.7 Screws, bolts, and similar fasteners used to secure sheet metal as the outer enclosure of an outdoor unit shall have a diameter at least 50 percent greater than the thickness of the sheet metal but no less than No. 6.

10 Securement with Adhesives

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

10.2 The requirement in 10.1 applies to an adhesive used to secure a part that, if loosened or dislodged, is capable of:

a) Energizing an accessible dead-metal part;

b) Making a live part that presents a risk of electric shock (as defined in 5.22) accessible;

c) Reducing spacings below the minimum values described in Spacings, Section 25;

d) Short-circuiting live parts; or

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

11 General Accessibility Requirements

11.1 To reduce the risk of unintentional contact with an uninsulated live part, film-coated wire, or a moving part that may involve a risk of injury, an opening in the enclosure of a unit shall comply with the requirements specified in Table 11.1.

Exception: A pump or heater need not comply with the requirements in Table 11.1 if it complies with the accessibility requirements for such equipment.

Table 11.1
Paragraphs, figures, and tables for evaluating the accessibility of uninsulated live parts, film-coated wire, and moving parts that may involve a risk of injury to persons

	Directly accessible motor	Indirectly accessible motor[a]	Enclosure other than that of a motor
Uninsulated live part	MD[b] < 25/32 inch 11.7 Figure 11.2 MD ≥ 25/32 inch 11.8 Figure 11.5 X = 3-5/32 inches	MD < 3/4 inch 11.7 Figure 11.3 MD ≥ 3/4 inch 11.8 Figure 11.5 X = 4 inches	MD < 1 inch 11.7 Figure 11.1 MD ≥ 1 inch 11.8 Figure 11.5 X = 6-1/16 inches
Film-coated wire	MD < 3/4 inch 11.7	MD < 3/4 inch 11.7	MD < 1 inch 11.7

Table 11.1 Continued on Next Page

Table 11.1 Continued

	Directly accessible motor	Indirectly accessible motor[a]	Enclosure other than that of a motor
	Figure 11.4 MD ≥ 3/4 inch 11.8 Figure 11.5 X = 4 inches	Figure 11.4 MD ≥ 3/4 inch 11.8 Figure 11.5 X = 4 inches	Figure 11.4 MD ≥ 1 inch 11.8 Figure 11.5 X = 6-1/16 inches
Moving part that may involve a risk of injury to persons	MD < 3/4 inch 11.7 Figure 11.4 MD ≥ 3/4 inch 11.9 Table 11.2	MD < 3/4 inch 11.7 Figure 11.3 MD ≥ 3/4 inch 11.9 Table 11.2	MD < 1 inch 11.7 Figure 11.1 MD ≥ 1 inch 11.9 Table 11.2

[a] See 11.5 for an explanation of an indirectly accessible motor.

[b] MD = See 11.6 for an explanation of a minor dimension of an opening.

NOTE – SI units for values specified in this table are:

3/4 inch (19.1 mm)

25/32 inch (19.8 mm)

1 inch (25.4 mm)

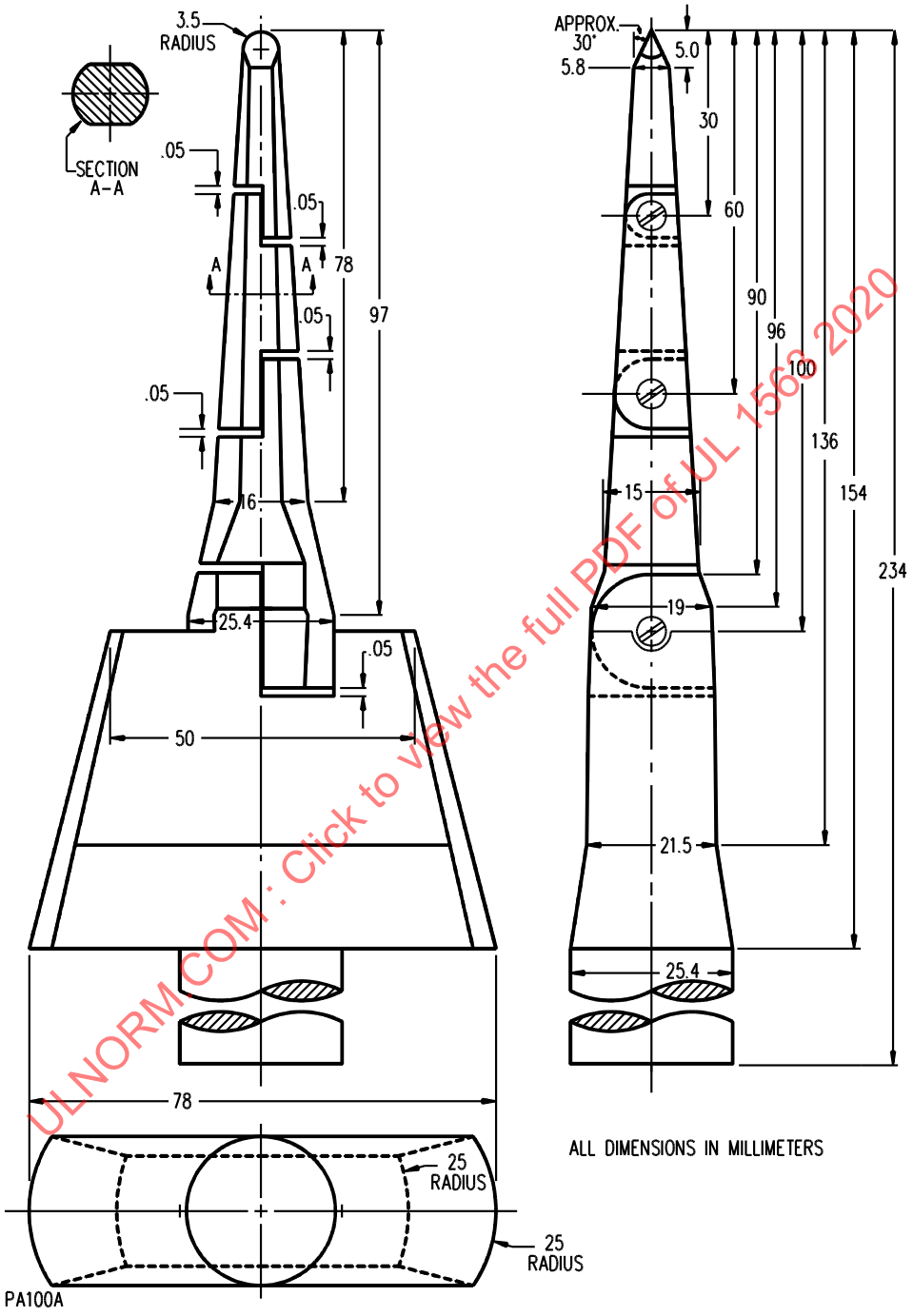
3-5/32 inches (80 mm)

4 inches (102 mm)

6-1/16 inches (154 mm)

Figure 11.1

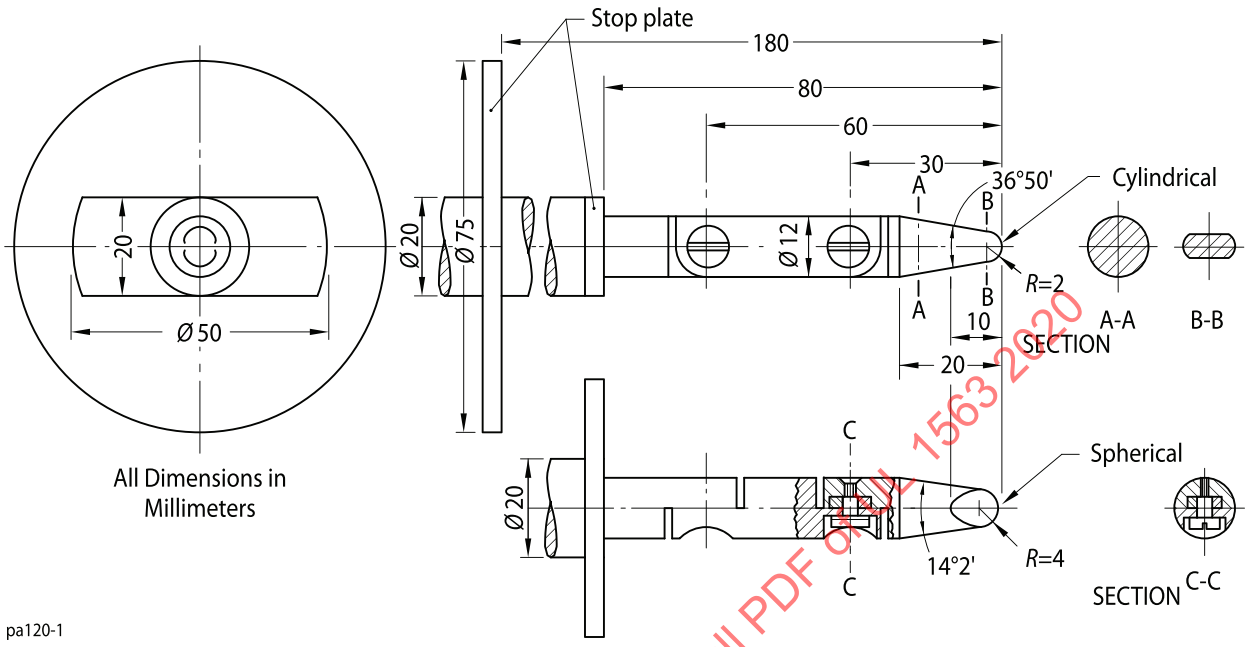
Articulate probe with web stop



NOTE – The UL articulate probe without the web stop may be used for openings having a minor dimension less than 3/4 inch (19.1 mm).

Figure 11.2

IEC articulate probe



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

Figure 11.3

Probe for moving parts and uninsulated live parts

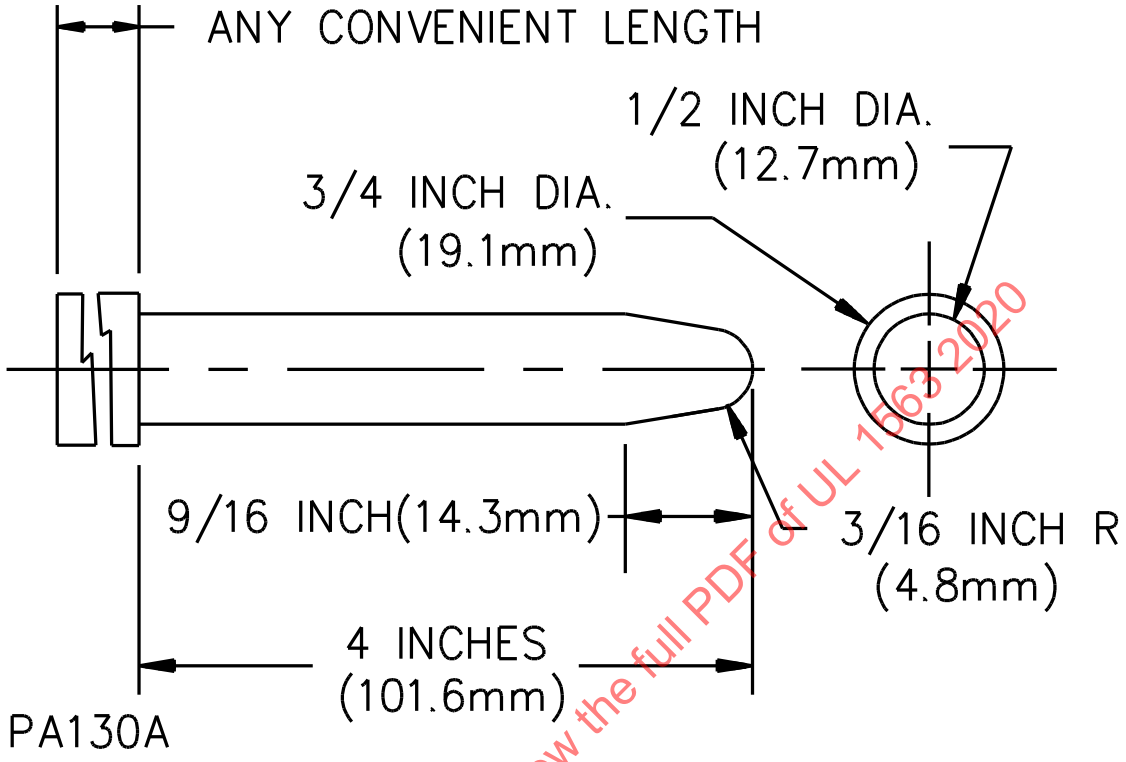


Figure 11.4

Probe for film-coated wire

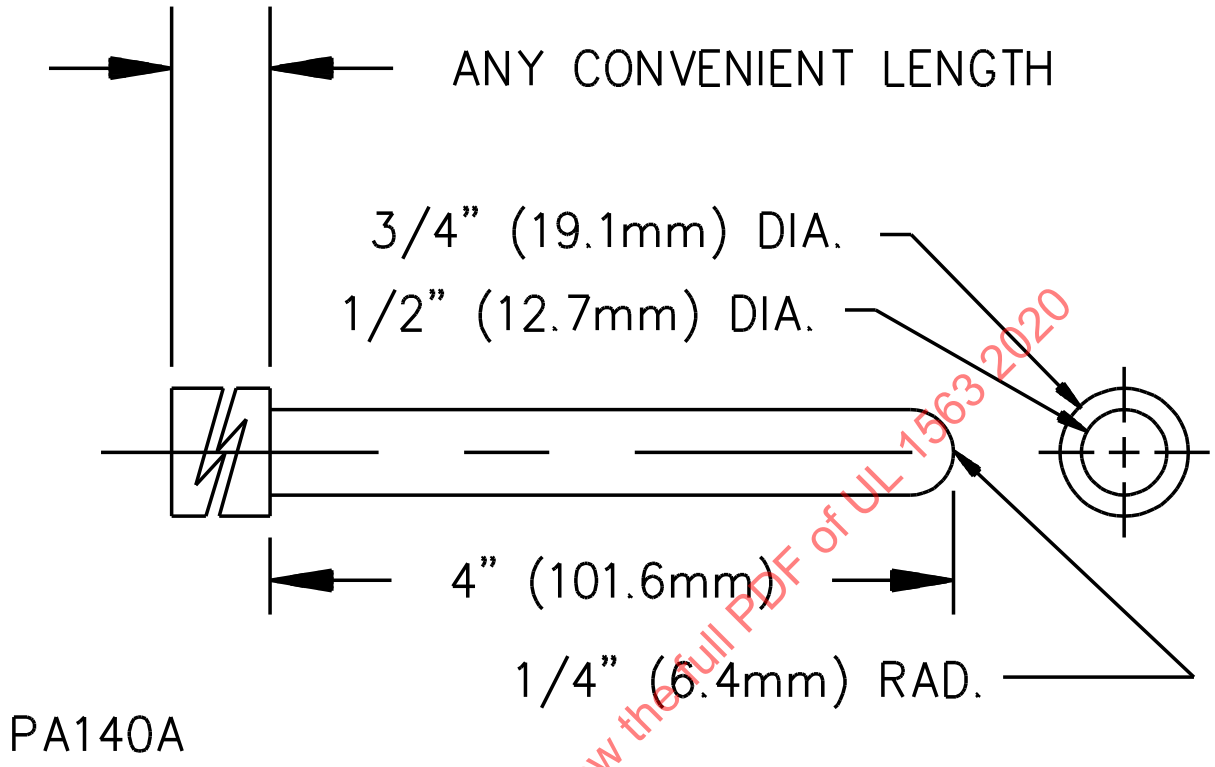
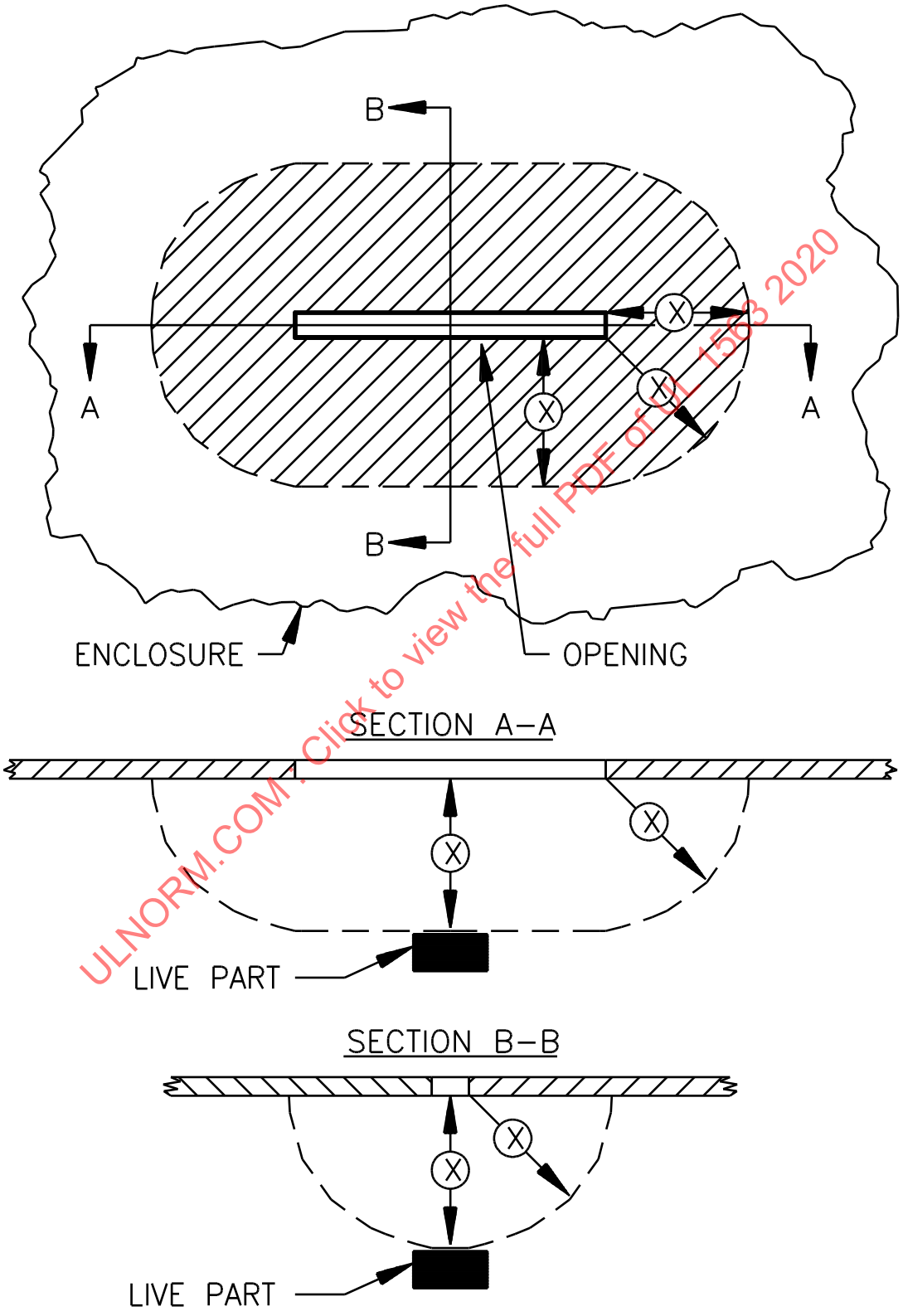


Figure 11.5

Opening in enclosure



11.2 With regard to the requirement in 11.1, insulated brush caps do not require additional enclosure.

11.3 During the examination of a unit to determine whether it complies with the requirements in 11.1 and Table 11.1, a part of the enclosure that may be removed, without using a tool, by the user to attach an accessory, to make an operating adjustment, or for other reasons is to be disregarded.

11.4 The probes illustrated in Figure 11.1 – Figure 11.4 shall be applied to any depth that the opening will permit and with a force not greater than 1 pound (4.4 N); and shall be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the unit. The probes illustrated in Figure 11.1 and Figure 11.2 shall be applied in any possible configuration; and, if necessary, the configuration shall be changed after insertion through the opening.

11.5 With reference to the requirements in Table 11.1, an indirectly accessible motor is a motor that is:

a) Accessible only by removing a part of the outer enclosure of a unit, such as a guard or panel, that can be removed without using a tool or

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

11.6 With reference to the requirements in Table 11.1, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening perpendicular to the plane of the opening with a force no greater than 5 pounds (22.2 N).

11.7 When Table 11.1 specifies a probe to be used to judge the accessibility of an uninsulated live part, film-coated wire, or a moving part that may involve a risk of injury to persons when inserted through an opening in the enclosure of a unit as described in 11.6, the probe shall not contact such a part or wire.

11.8 When Table 11.1 does not specify a probe to be used to judge the accessibility of an uninsulated live part or film-coated wire, such a part or wire shall not be:

a) Within X inches of the perimeter of an opening in the enclosure of a unit or

b) Within the volume generated by projecting the perimeter X inches normal to its plane. X equals five times the minor dimension of the opening, as illustrated in Figure 11.5, but no less than the values specified in Table 11.1.

11.9 When Table 11.1 does not specify a probe to be used to judge the accessibility of a moving part that may involve a risk of injury to persons, the distance between the plane of an opening in the enclosure and the moving part shall be at least as specified in Table 11.2.

Table 11.2
Minimum distance from an opening to a moving part that may involve a risk of injury to persons

Minor dimension[a] of opening,		Minimum distance from opening to part,	
inches	(mm)	inches	(mm)[b]
3/4	19.1	4-1/2	114.3
1	25.4	6-1/2	165.1
1-1/4	31.8	7-1/2	190.5
1-1/2	38.1	12-1/2	317.5
1-7/8	47.6	15-1/2	393.7

Table 11.2 Continued on Next Page

Table 11.2 Continued

Minor dimension[a] of opening,		Minimum distance from opening to part,	
inches	(mm)	inches	(mm)[b]
2-1/8	54.0	17-1/2	444.5
See footnote c		30	762.0

[a] See 11.6 for an explanation of a minor dimension of an opening.

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

[c] More than 2-1/8 inches, but no more than 6 inches (152 mm).

12 Accessibility Requirements For Spas

12.1 Grounded metal shall not be accessible to the occupant.

12.2 Any part of a spa that is accessible to the occupant shall be made of nonconductive material.

Exception No. 1: A permanently wired self-contained spa may be equipped with an accessible metal ladder or other similar metal hardware if provided with the bonding specified in 17.5 and the installation instructions specified in 74.4.

Exception No. 2: A spa may be provided with small conductive surfaces such as air and water jets, bezels, nameplates, drain fittings, skimmers, towel bars, and handholds provided each conductive surface is isolated from all internal wiring and is not grounded or likely to become grounded.

12.3 Openings in the outer enclosure of a spa are acceptable if the minor dimension does not exceed 1 inch (25.4 mm) and the accessibility probe illustrated in Figure 11.1 does not contact a capillary tube, internal wiring, or grounded metal. The probe shall be applied with a maximum force of 1 pound (4.4 N) and shall be angled and rotated to any possible position using any possible configuration.

12.4 Grounded metal shall be spaced not less than 1/16 inch (1.6 mm) from dead metal accessible to the occupant, nonmetallic material accessible to the occupant, and the supporting surface of the spa.

Exception No. 1: Spacings between grounded metal and the tub or skirting material are not required if the tub or skirting material complies with the Dielectric Voltage-Withstand Test, Section 49.

Exception No. 2: An additional material may be used in lieu of the spacings specified in 12.4 if the additional material complies with the ENCLOSURES – General section, Material Property Considerations section, and Internal Barriers section requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

12.5 A polymeric enclosure that is not accessible to the occupant but that contains parts that may present a risk of electric shock shall, in addition to complying with 8.3.3, be spaced not less than 1/16 inch (1.6 mm) from:

a) Grounded metal;

b) Dead metal and nonmetallic materials accessible to the occupant; and

c) The supporting surface of the spa.

Exception No. 1: Spacings between the enclosure and the tub or skirting material are not required if the tub or skirting material complies with the Dielectric Voltage-Withstand Test, Section 49.

Exception No. 2: An additional material may be used in lieu of the spacings specified in 11.5 if the additional material complies with the ENCLOSURES – General section, Material Property Considerations section, and Internal Barriers section requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

12.6 A polymeric enclosure containing parts that may present a risk of electric shock may be accessible to the occupant if, in addition to complying with the requirements in 8.3.3:

a) The enclosure complies with the Material Property Considerations section in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and live parts are spaced not less than 1/2 inch (12.7 mm) from the inside surface of the enclosure; or

b) The enclosure and one additional material that is positioned between the live parts and the inside surface of the enclosure comply with the Material Property Considerations section in UL 746C; or

c) A material that complies with the Material Property Considerations section in UL 746C is positioned between the live parts and the inside surface of the enclosure with a minimum 1/2 inch spacing between the live parts and the material; or

d) The enclosure complies with the Material Property Considerations section in UL 746C and the enclosure is not less than 3/16 inch (4.8 mm) thick.

Also see 32.7.

Exception: In addition to complying with the requirements in 8.3.3, if the part that presents a risk of electric shock is located in a Class 2 circuit, the insulating material or enclosure need only comply with the dielectric voltage-withstand strength requirements in the Material Property Considerations section in UL 746C.

12.7 For a light-emitting diode connected to a Class 2 circuit, the lens of the LED need not be evaluated to the dielectric voltage-withstand strength requirements in the Material Property Considerations section in Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, provided the lens is at least 1/16 inch thick.

12.8 A live part or circuit may be accessible to the occupant or in contact with circulating water if:

a) The live part is located in the secondary circuit of a transformer that complies with the requirements in Transformers and Power Supplies, Section 31; and

b) The live part does not present a risk of electric shock; and

c) The live part is separated from other live parts, grounded metal, and all other wiring by permanent spacings or by two independent materials that comply with the insulation requirements specified in the Material Property Considerations section in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

12.9 A luminaire in a spa 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.

13 Resistance to Corrosion

13.1 An iron or steel part shall be resistant to corrosion by enameling, galvanizing, plating, or equivalent means, if the corrosion of such a part would be likely to result in a risk condition.

Exception No. 1: In certain instances where the oxidation of iron or steel due to the exposure of the metal to air and moisture is not likely to be appreciable – thickness of metal and temperature also being factors – surfaces of sheet steel and cast iron parts within an enclosure may not be required to be corrosion resistant.

Exception No. 2: The requirement does not apply to bearings, laminations, or to minor parts of iron or steel such as washers and screws.

Exception No. 3: Stainless steel requires no corrosion-resistant coating.

13.2 Copper or copper alloy with zinc content not in excess of 15 percent may be used without additional resistance to corrosion.

13.3 Aluminum may be used without additional resistance to corrosion.

13.4 When, during intended use, sheet and plate aluminum comes into contact with tub water, it shall be of an alloy of the 5000 series as given in the American National Standard Specification for Aluminum-Alloy Sheet and Plate, ANSI/ASTM B209; and cast aluminum shall be one of the alloys shown in Table 13.1 or an alloy that has been found to have equivalent resistance to corrosion.

Table 13.1
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	6063Z
S5B	SG70B	SG100B	
SG70A			
ZG61B			

13.5 Metal shall not be used in combinations to cause galvanic action.

13.6 A sheet steel enclosure and other parts, including hinges and other attachments, of an indoor or outdoor unit shall be resistant to corrosion as described in 13.7 – 13.9.

13.7 An enclosure that is entirely within the outer enclosure of a unit, and that contains any live part other than a motor, shall be resistant to corrosion as specified in 13.8 (c), with or without the added epoxy or paint coating or other means described in 13.8 and 13.9.

13.8 The outer sheet steel enclosure shall be resistant to corrosion by one of the following:

a) Hot-dipped, mill-galvanized sheet steel conforming with the coating designation G90 in the Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated

(Galvannealed) by the Hot Dip Process, ASTM A 653/653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM designation. The weight of the zinc coating may be determined by any method; however, in case of question, the weight of coating shall be established in accordance with the Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M REV A.

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 established by the test method described in 62.1. An annealed coating shall also comply with 13.9.

c) A coating conforming with subitem (1) or (2) and with one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on both surfaces. The acceptability of the paint may be determined by consideration of its composition or by corrosion tests if these are considered necessary.

1) Hot-dipped, mill-galvanized sheet steel conforming with the coating designation G60 or A60 in Table I of ASTM A653/A653M, with not less than 40 percent of the zinc on any side, based on the minimum single spot test requirement in this ASTM standard. The weight of the zinc coating may be determined by any method; however, in case of question the weight of coating shall be established in accordance with the test method of ASTM A90/A90M REV A. An annealed coating shall also comply with 13.9.

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 (0.013 mm) on each surface with a minimum thickness of 0.00034 inch (0.009 mm). The thickness of the coating shall be established by the test indicated in 62.1. An annealed coating shall also comply with 13.9.

d) A cadmium coating not less than 0.0010 inch (0.025 mm) thick on both surfaces. The thickness of the coating shall be established by the test indicated in 62.1.

e) A cadmium coating not less than 0.00075 inch (0.019 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.00051 inch (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established by the test indicated in 62.1, and the paint shall be as described in 13.8(c).

f) Other finishes, including paints, special metallic finishes, and combinations of the two may be accepted when comparative test with galvanized sheet steel (without annealing, wiping, or other surface treatment) conforming with 13.8 (a) indicate that they provide equivalent resistance to corrosion. Among the factors that are taken into consideration when evaluating such coating systems are exposure to salt spray, moist carbon dioxide-sulfur dioxide 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.

13.9 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. When 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. Sheared or cut edges and punched holes are not required to be additionally treated.

14 Power Supply Connections – Cord-Connected and Convertible Spas and Equipment Assemblies

14.1 A non-detachable power supply cord shall be provided on each cord-connected and convertible spa and equipment assembly. When intended for indoor use, or both indoor and outdoor use, the electrical rating shall not exceed 20 amperes. When marked "For outdoor use only," this restriction does not apply.

14.2 The cord mentioned in 14.1 shall be Type SW, SEW, SOW, STW, SEOW, SEOOW, STOW, STOOW or equivalent hard-service cord that is suitable for use outdoors and immersion in water with a grounding conductor and an attachment plug. The cord shall extend at least 10 feet (3.05 m) but no more than 15 feet (4.57 m) from the product to the face of the attachment plug. The ampacity of the cord shall be no less than the current rating of the product, and the ampacity of the attachment plug shall be no less than 125 percent of the current rating of the product.

14.2.1 The flexible cord specified in 14.2 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.

14.3 A 2-prong grounding adapter with a pigtail shall not be provided.

14.4 The cord specified in 14.1 is not prohibited from being marked on its exterior surface with the words "Water Resistant."

14.5 The grounding conductor shall be no smaller than the circuit conductors in the cord.

14.6 Each cord-connected and convertible spa shall be provided with an entry for the power supply cord that is smooth and free from sharp edges.

14.7 Strain relief shall be provided to reduce the risk of mechanical stress on a flexible cord being transmitted to terminals, splices, or interior wiring. The strain relief shall be independent of any necessary water seals and shall not cause flexing or movement of any such seals.

14.8 Unless the clamp is insulated from the cord, a metal strain relief clamp shall not be accessible and shall not make contact with an accessible dead metal part.

14.9 Means shall be provided to prevent the flexible cord from being pushed back through the cord entry hole if such displacement is likely to subject the cord to mechanical damage or to expose it to a temperature higher than that for which it is rated, or is likely to reduce spacings to less than the values specified in Spacings, Section 25.

14.10 A knot in the supply cord shall not be used to provide strain relief.

15 Power Supply Connections – Permanently Connected Units

15.1 General

15.1.1 A unit intended for permanent connection shall be provided with wiring terminals or leads for the connection of power supply conductors.

15.1.2 A unit rated for use at more than one supply voltage shall have provision for operating at each supply voltage without disrupting internal wiring or connections other than in the area of field wiring.

15.1.3 Sheet metal to which a wiring system is to be connected in the field shall be no less than 0.032 inch (0.81 mm) thick steel if uncoated, no less than 0.034 inch (0.86 mm) thick steel if galvanized, or no less than 0.045 inch (1.14 mm) thick if nonferrous.

15.1.4 A unit intended for installation outdoors shall have a provision for threaded connection of rigid metal conduit unless the hole for the connection to the conduit is located wholly below the lowest uninsulated live part within the enclosure, the location reduces drainage into the conduit, or the connection is within an overall enclosure.

15.1.5 When the threads are tapped all the way through a hole in an enclosure wall, or if an equivalent construction is employed, there shall be no less than 3-1/2 nor more than 5 threads in the metal, and the construction shall be such that a conduit bushing can be attached. When the threads are not tapped all the way through a hole in an enclosure wall, conduit hub, or the like, there shall be no fewer than 5 full threads in the metal, and there shall be a smooth, well-rounded inlet hole for the conductors that:

a) Provides protection to the conductors equivalent to that provided by a standard conduit bushing and

b) Has an internal diameter approximately the same as that of the corresponding trade size of rigid conduit.

15.1.5.1 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.

15.1.6 A metal conduit hub in an enclosure shall be threaded and shall have a wall thickness before threading no less than that of the corresponding trade size of conduit. A conduit hub that is not cast integrally with an enclosure shall not depend upon friction alone to restrain its turning and shall be capable of withstanding the specified torque applied to a short length of rigid conduit threaded into the hub in the intended manner, without turning in the enclosure and without stripping of any threads. The enclosure shall be rigidly mounted or supported. For the 3/4 inch and smaller trade sizes, the applied torque shall be 800 pound-inches (90.4 N·m); for the 1, 1-1/4, and 1-1/2 inch trade sizes, 1000 pound-inches (113 N·m); and for the 2 inch and larger trade sizes, 1600 pound-inches (181 N·m).

15.1.7 A knockout for connection of a field wiring system to a field wiring compartment shall accommodate conduit of the trade size shown in Table 15.1.

Table 15.1
Trade size of conduit, inches

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

Table 15.1 Continued on Next Page

Table 15.1 Continued

Wire size,		Number of wires				
AWG	(mm^2)	2	3	4	5	6
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 no more than six conductors in the conduit. When 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 2.5 times the total cross-sectional area of the wires, based on the cross-sectional area of Type THW wire.						

15.2 Terminal compartments for supply connection

15.2.1 A unit intended for permanent connection shall be provided with a terminal compartment intended for connection of a supply raceway. Additionally, the terminal compartment shall be attached to the unit so as to be restricted from turning with regard to the unit.

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" or the equivalent, is considered to comply with the requirements for a terminal compartment specified in 15.2.1 – 15.2.3.

15.2.2 A terminal compartment in which connections to the power supply circuit will be made shall be so located that, after the unit has been installed as intended, such connections will be accessible for inspection.

15.2.3 A terminal compartment shall be complete and shall enclose all field wiring terminals and all splices to be made in the field unless the enclosure is otherwise complete; that is, unless all sides and a complete bottom are provided when the unit is shipped from the factory. No ventilating opening shall be located in the terminal compartment.

Exception: A ventilated terminal compartment may be used in a ventilated motor frame having ventilating openings if there is no opening directly beneath any live part in the compartment.

15.2.4 The compartment mentioned in 15.2.2 shall be located so that when conduit connections are being made, internal wiring and electrical components shall not be exposed to mechanical abuse or strain. Electrical components shall not be mounted on the terminal compartment cover unless a method of disconnection is provided for each component.

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

15.2.6 A unit with a terminal box or wiring compartment that attains a temperature exceeding:

a) 60°C (140°F) for a unit rated 100 amperes or less or

b) 75°C (167°F) for a unit rated more than 100 amperes shall be marked as specified in 70.6.

15.3 Wiring terminals and leads

15.3.1 The wiring terminals specified in 15.1.1 shall be rated for the connection of conductors sized in accordance with Table 15.2 or Table 15.3.

Table 15.2
Supply wire sizes (copper) and overcurrent protection for permanently-connected units

Ampere rating of the unit		Supply wire type and size[a]		Overcurrent protection, amperes[b]
More than	To	60°C Copper, AWG	75°C Copper, AWG	
0	12	14	14	15
12	16	12	12	20
16	20	10	10	25
20	24	10	10	30
24	28	8	10	35
28	32	8	8	40
32	36	6	8	45
36	40	6	8	50
40	48	4	6	60
48	56	4	4	70
56	64	3	4	80
64	68	3	4	90
68	72	2	3	90
72	76	2	3	100
76	80	1	3	100
80	88	1	2	110
88	92	1/0	2	125
92	100	1/0	1	125

[a] Wire sizes are predicated on units intended for continuous duty based on Table 310-16 of the National Electrical Code, ANSI/NFPA 70, using 60°C ampacities for circuits rated 100 amperes or less and 75°C ampacities for circuits rated more than 100 amperes.

[b] Assumed branch circuit overcurrent protection.

Table 15.3
Supply wire sizes (aluminum) and overcurrent protection for permanently-connected units

Ampere rating of the unit		Supply wire type and size[a]		Overcurrent protection, amperes[b]
More than	To	60°C aluminum, AWG	75°C aluminum, AWG	
0	12	12	12	15
12	16	10	10	20
16	20	10	10	25
20	24	8	8	30
24	28	6	8	35
28	32	6	8	40
32	36	4	6	45
36	40	4	6	50
40	48	3	4	60
48	56	2	3	70
56	64	1	2	80
64	68	1	2	90
68	72	1/0	2	90
72	76	1/0	1	100

Table 15.3 Continued on Next Page

Table 15.3 Continued

Ampere rating of the unit		Supply wire type and size[a]		Overcurrent protection, amperes[b]
More than	To	60°C aluminum, AWG	75°C aluminum, AWG	
76	80	1/0	1	100
80	88	2/0	1/0	110
88	92	2/0	1/0	125
92	100	3/0	2/0	125

[a] Wire sizes are predicated on units intended for continuous duty based on Table 310-16 of the National Electrical Code, ANSI/NFPA 70, using 60°C ampacities for circuits rated 100 amperes or less and 75°C ampacities for circuits rated more than 100 amperes.

[b] Assumed branch circuit overcurrent protection.

15.3.2 Unless marked for use only with wire rated 75°C (167°F), the size of the conductors is to be based upon wire rated for 60°C (140°F) temperature for circuits rated 100 amperes or less; and 75°C for circuits rated more than 100 amperes.

15.3.3 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 71.1.

15.3.4 Wire-bending space at field wiring terminals shall be as specified in Table 15.4.

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" or the equivalent, is considered to comply.

Table 15.4
Minimum wire-bending space

Wire size,		Minimum wire-bending space from terminal to wall,	
AWG	(mm^2)	inch	(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
3	26.7	3	76.2
2	33.6	3–1/2	88.9
1	42.4	4–1/2	114.3
1/0	53.5	5	127
2/0	67.4	6	152

[a] Minimum wire-bending space is based on Table 312.6(B) in the National Electrical Code, ANSI/NFPA 70.

15.3.5 A wiring terminal shall be provided with pressure wire connectors, bolted or held by a machine screw.

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

15.3.6 When 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).

15.3.7 A wire-binding screw shall thread into metal.

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

Exception: A No. 8 (4.22 mm diameter) screw may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm^2) conductor, and a No. 6 (3.5 mm diameter) screw may be used for the connection of a 16 AWG (1.3 mm^2) or 18 AWG (0.82 mm^2) conductor in a control circuit.

15.3.9 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 at a terminal for connection of a power supply wire.

15.3.10 A terminal plate tapped for a wire-binding screw shall be of metal no less than 0.030 inch (0.76 mm) thick. There shall be no fewer than two full threads in the metal, which may be extruded if necessary to provide the threads.

15.3.11 A unit intended for connection to a grounded power supply conductor and employing a lampholder of the Edison screw shell 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 screw shells of lampholders and shall not be the one connected to a single pole switch or control.

15.3.12 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 proper 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.

15.3.13 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.

15.3.14 The requirement in 15.3.13 relating to color coding for identification does not apply to internal wiring that is not visible in a wiring compartment in which field connections are to be made.

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

15.3.16 The leads specified in 15.1.1 shall be no more than two sizes smaller than the intended supply conductors but, in any case, no smaller than 18 AWG (0.82 mm^2). The size of the supply conductors is to be based on the ampacity of the unit using Table 15.2 or Table 15.3.

Exception: 18 AWG leads may be provided for connection to 14 or 12 AWG (2.1 or 3.3 mm^2) supply conductors.

15.3.17 A convertible unit shall be provided with connections to have provision for converting from a cord-connected configuration to a permanently wired configuration without disrupting internal wiring or connections other than in the area of field wiring.

15.3.18 A unit rated 120/240 volts shall have provision for converting either supply voltage without changing or disrupting internal wiring or connections other than at the point of field wiring. A wiring diagram shall be provided as specified in 71.1.

16 Grounding

16.1 Except for a cord-connected unit, each unit shall be provided with a lead or a pressure wire connector mounted within the terminal compartment specified in 15.2.1 to terminate the grounding conductor of the supply circuit. The lead or connector shall be sized in accordance with Table 16.1.

Table 16.1
Minimum size of equipment grounding conductor

Rating of branch circuit protective device, amperes	Copper wire, AWG
15	14
20	12
30	10
40	10
60	10
100	8

16.2 The grounding conductor of the power supply cord of a cord-connected (not convertible) unit shall be terminated by a screw that is not used for any purpose other than for servicing of the supply cord. The grounding screw shall thread into metal within the terminal compartment using at least two full threads and shall employ a lockwasher or similar device.

16.3 For a cord-connected or convertible unit, the grounding conductor in the cord shall be sized in accordance with 14.2 and 14.5.

16.4 A lead intended for connection to an equipment grounding conductor shall have a free length of not less than 6 inches (152 mm).

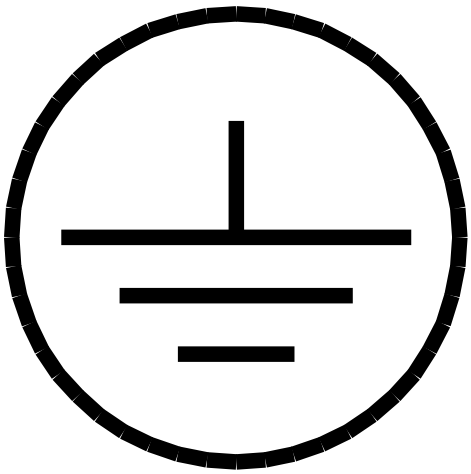
16.5 The surface of an insulated lead intended to connect an equipment grounding conductor shall be green with or without one or more yellow stripes. No other lead that is located in the field wiring compartment and that is visible to the installer shall be so identified.

16.6 The pressure wire connector intended to terminate the equipment grounding conductor shall be plainly marked "G," "GR," "Ground," or "Grounding."

16.7 The grounding symbol illustrated in Figure 16.1 (IEC Publication 60417, Symbol No. 5019) may be used for the purpose specified in 16.2 and shall be marked adjacent to the terminal or on a wiring diagram provided on the unit.

Figure 16.1

Grounding symbol



16.8 A convertible unit shall have separate grounding terminations identified and sized to correspond with each electrical rating. Instructions for converting from cord to permanent grounding shall be provided in the terminal compartment.

Exception: A single grounding termination may be provided if suitable for both electrical ratings.

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

17 Bonding

17.1 For other than those items specified in Exception Nos. 1 and 2 to 12.2 and 17.2, the metal enclosure of each electrical component and all accessible metal that could become energized in the event of a fault shall be bonded to the equipment grounding specified in Grounding, Section 16. Bonding shall be by conductive metal-to-metal mounting or by bonding conductors as specified in 17.2 or 17.3. The metal-to-metal connection shall be made by bolting, brazing, or welding. Metal screws may be used for a metal-to-metal bonding connection if retained by at least two full threads. All bonding connections shall penetrate paint and other nonconductive coatings.

Exception: Double-insulated pumps and blowers are not required to be bonded to the equipment grounding conductor.

17.2 For other than a heater, pump, or a current collector, electrical components under the skirt of a spa that are connected by a jacketed flexible cord may use the grounding conductor in the flexible cord for bonding.

17.3 A bonding conductor shall be solid copper not smaller than 8 AWG (8.4 mm^2) and may be insulated, covered, or bare. A bonding conductor shall be routed close to the contour of the equipment frame to reduce the risk of abuse during servicing.

17.4 A soldering lug, push-in connector, quick-connect, or similar friction-fit connector shall not be used to terminate or splice a bonding or grounding conductor.

17.5 A permanently wired spa provided with accessible metal as specified in Exception No. 1 to 12.2, shall have each accessible metal ladder or other accessible metal hardware bonded to every other accessible metal ladder or other accessible metal hardware. In addition, the spa shall contain provision for bonding the accessible metal ladder (s) and other accessible metal hardware to the grounding means specified in Grounding, Section 16, but only when the spa is being installed at a field location. This bonding connection shall not be made at the factory.

17.6 A pressure wire connector, sized to accommodate a 8 AWG (8.4 mm^2) solid copper conductor, shall be provided to bond the unit to the local common bonding grid during installation. The wire connector shall be conductively connected to the grounding means specified in Grounding, Section 16.

17.7 When a unit is constructed to supply electrical power to a field-installed electrical appliance (other than providing a simple control or pilot duty function), one additional pressure wire connector sized to accommodate a 8 AWG (8.4 mm^2) solid copper conductor shall be provided to bond each additional appliance.

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

18 Leakage Current Collectors

18.1 When a water heater in a unit is not provided with a grounded metal enclosure, a leakage current collector shall be provided in the water-circulating system between the points of pickup of water from the tub or spa and the inlet to any electrical component, and another between the point of return of the water to the tub or spa and any electrical component. The installation of the collectors shall be such that all water entering and leaving the tub flows through the two collectors.

Exception: Other construction features or protective devices may be used if determined by the Leakage Current Test in Water, Section 55, to limit the available leakage current in the water-circulating system.

18.2 A leakage current collector shall be made of an unplated metal such as brass, stainless steel, or other equally corrosion-resistant metal that is intended to resist galvanic action in accordance with 13.4. Galvanized metal pipe is not considered to be sufficiently corrosion-resistant for use as a current collector. When copper alloy is used, it shall be comprised of not more than 15 percent zinc. A circular leakage current collector shall have a minimum length of five times its own inside diameter.

Exception: Leakage current collectors of other types or forms may be used if the collectors are found to limit the available leakage current in the water-circulating system when subjected to the Leakage Current Test in Water, Section 55.

18.3 A leakage current collector, if provided, and all other grounded metal in the water circulating system shall be isolated by nonconductive pipe for at least:

a) Twelve inches (305 mm) from the nearest opening to the tub if 2-inch (50.8-mm) or smaller inner diameter pipe is used or

b) Twenty-seven inches (686 mm) from the nearest opening to the tub if pipe larger than 2 inches in diameter is used.

18.4 A leakage current collector shall be permanently factory installed on the unit and bonded as described in 17.3.

19 Live Parts

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

19.2 Plated iron or steel may be used for a current-carrying part:

a) Whose temperature during intended operation is more than 100°C (212°F);

b) Within a motor or associated governor; or

c) When it is in accordance with 7A.1.1.

Plain (unplated) iron or steel shall not be used. The foregoing restrictions do not apply to stainless steel and other corrosion-resistant alloys.

20 Wiring

20.1 General

20.1.1 All wiring shall be within an enclosure as specified in Frame and Enclosure, Section 8, or within a raceway such as flexible or rigid conduit, electrical metallic tubing, or the equivalent.

Exception No. 1: For other than a safety circuit, wiring that complies with the requirements in 12.8 is exempt from this requirement if the wiring is prevented from contacting grounded metal, live parts, and all other wiring as specified in Spacings, Section 25.

Exception No. 2: Wiring between component enclosures that complies with the requirements specified in 20.3.1 and 20.3.2 is exempt from this requirement.

Exception No. 3: Wiring on the secondary of a Class 2 transformer that complies with the requirements in Transformers and Power Supplies, Section 31, is exempt from this requirement if the wiring is prevented from contacting grounded metal, live parts, and all other wiring as specified in Spacings, Section 25.

20.1.2 Wires and cords shall be rated for the temperature and voltage to which they will be subjected in intended use.

20.1.2.1 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.

20.1.3 Wiring for components mounted on the cover of a field wiring compartment shall use stranded conductors.

20.1.4 Wires within an enclosure, compartment, raceway, or the like shall be located or protected to reduce the risk of contact with any sharp edge, burr, fin, moving part, or the like that may abrade the insulation on conductors or otherwise damage the wiring.

20.1.5 The means of connecting stranded internal wiring to a wire-binding screw shall be such that loose strands of wire will not contact other live parts not always of the same polarity as the wire and dead metal parts. This may be accomplished by use of pressure terminal connectors, soldering lugs, or crimped eyelets; by soldering all strands of the wire together; or by equivalent means.

20.2 Splices and connections

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

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

20.2.3 Each splice, each connector, and each terminal connection shall be located within an enclosure as specified in Frame and Enclosure, Section 8.

Exception: Connectors that are located under the skirt of a spa and that comply with the requirements in 20.3.4 need not comply with this requirement.

20.2.4 Terminals or leads shall not be provided for field connection of circuits intended to supply sensors or controls that are in contact with the tub water or within reach of an occupant of the tub.

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

20.2.6 An aluminum conductor, insulated or uninsulated, used as internal wiring, such as for interconnection between current-carrying parts or as a motor winding, shall be terminated at each end by a method that is intended to be used for the combination of metals involved at the connection point.

20.2.7 With reference to 20.2.6, a wire-binding screw or a pressure wire connector used as a terminating device shall be intended for use with aluminum under the intended operating conditions such as temperature, heat cycling, vibration, and the like.

20.3 Wiring between component enclosures

20.3.1 Wiring between component enclosures may be in Type SW or STW flexible cord or the equivalent. When used where protected under the skirt of a spa, the cord may be Type SJ, SJT, or the equivalent.

20.3.1.1 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.

20.3.2 Strain-relief complying with 14.7 – 14.10 shall be provided where a cord enters a component enclosure.

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

a) Located entirely under the skirt of a spa,

b) Mounted to prevent movement that could transmit strain to a connection, and

c) Located where it is not likely to be moved during user servicing.

20.3.3 Wiring between component enclosures shall not contact metal that is accessible to the occupant.

20.3.4 Wiring that is located entirely under the skirt of a spa and that is not likely to be moved during user servicing may be provided with an insulated plug-connector combination when:

a) The plug-connector combination is suitable for the voltage and temperature involved;

b) The contacts do not exceed a 30°C (86°F) temperature rise when carrying the maximum circuit current;

c) The contact-to-contact spacing complies with the requirements specified in Spacings, Section 25;

d) Live parts are not accessible when the connection is broken; and

e) The circuit involved is not a safety circuit.

Exception: The circuit involved may be a safety circuit when opening of the circuit does not defeat the safety function.

20.3.5 A flexible cord, when used as the wiring for an insulated plug-connector combination as specified in 20.3.4, may have the cord jacket removed for a short distance when needed to permit entry of the insulated conductors into the connector body.

21 Heating Elements

21.1 A heating element shall be securely supported.

21.2 In determining compliance with 21.1, consideration is to be given to sagging, loosening, and other adverse conditions of the element resulting from continuous heating or flexing of the element supports or related wiring due to alternate heating and cooling.

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

21.4 The current through each heating element shall not exceed 48 amperes.

22 Separation of Circuits

22.1 Unless segregated, routed, or secured to provide permanent spacings as specified in Spacings, Section 25, each conductor shall be insulated for the highest potential involved with regard to:

a) Uninsulated live parts,

b) Accessible metal,

c) Grounded metal,

d) Circuits accessible to the occupant or in contact with circulating water, and

e) Other insulated conductors including safety circuits and Class 2 circuits.

Exception: Insulation or spacing between two parts is not required if short circuiting the two parts does not result in:

a) A risk of fire, electric shock, or injury to persons or

b) The impairment of a required safety function.

23 Electrical Insulation

23.1 An insulating washer, bushing, or other integral part and a base or support for the mounting of a live part shall be of a moisture-resistant insulating material that will not be adversely affected by the temperatures to which it is likely to be subjected during use. A molded part shall be so constructed that it will have mechanical strength and rigidity to withstand the stresses of use.

23.2 Materials such as mica, some molded compounds, and certain refractory materials may be used as the sole support of a live part. Some other materials such as magnesium oxide that are not intended for general use may be used if such materials are used in conjunction with other appropriate insulating materials, or if so located or guarded that the risk of mechanical damage and the absorption of moisture will be reduced.

23.3 When it is necessary to investigate a material to determine acceptability, consideration shall be given to its mechanical strength, dielectric properties, insulation resistance, heat resistance, the degree to which it will be enclosed or guarded, and to any other features that may have a bearing on the performance of the material during use. All of these factors shall be considered with regard to thermal aging in accordance with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

23.4 The polymeric materials specified in 23.3 shall comply with the Standard for Polymeric Materials – Fabricated Parts, UL 746D, as specified in 8.3.6.

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

24 Printed-Wiring Boards

24.1 A printed-wiring board shall comply with the requirements in the Standard for Printed-Wiring Boards, UL 796.

24.2 A printed-wiring board shall be rated a minimum of V-2 as specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

24.3 A printed-wiring board assembly containing safety circuitry shall be provided with a conformal coating that complies with the requirements for a conformal coating in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. When a safety circuit derives its power from additional circuitry located on a separate printed-wiring board, then the additional printed-wiring board is required to have a conformal coating so as not to jeopardize the reliability of the safety circuit.

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 may be used in lieu of a conformal coating when the protective coating is tested on the printed-wiring board and complies with the requirements specified in UL 746C.

Exception No. 3: A conformal coating is not required to be provided when the printed-wiring board has construction features determined by investigation to provide equivalent protection.

24.4 A printed-wiring board shall comply with the requirements for the direct support of current-carrying parts specified in the Standard for Printed-Wiring Boards, UL 796.

Exception: A printed-wiring board containing only Class 2 circuits is exempt from this requirement if the circuits are not subsequently used as a safety circuit or where accessible to the occupant or in contact with circulating water.

24.5 The securing of electrical components to a printed-wiring board to form a printed wiring assembly and the mounting of the printed wiring assembly itself shall be such that any forces that might 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 to the extent as to produce a risk of fire or electric shock.

25 Spacings

25.1 General

25.1.1 Spacings in this standard do not apply to the internal spacings of a component if the component complies with the spacing requirements specified in the component standard.

25.1.2 All uninsulated live parts connected to different circuits shall be considered as though they were of opposite polarity. Opposite polarity spacings shall be required on the basis of the highest voltage involved.

25.2 Field wiring terminals

25.2.1 Through air and over surface spacings shall not be less than 1/4 inch (6.4 mm) between:

a) Field wiring terminals of opposite polarity and

b) Field wiring terminals and accessible metal, grounded metal, the enclosure, and all other uninsulated live parts.

Exception: Spacings for field wiring terminals are not specified for Class 2 circuits that are not

a) Safety circuits or

b) Circuits accessible to the spa occupant or in contact with the spa water.

25.3 Spacings at other than field wiring terminals or on printed wiring boards

25.3.1 Line voltage parts

25.3.1.1 Through air and over surface spacings shall not be less than 3/32 inch (2.4 mm) between:

a) Uninsulated live parts of opposite polarity and

b) Uninsulated live parts and accessible metal, grounded metal, and the enclosure.

25.3.2 Grounded metal

25.3.2.1 Through air and over surface spacings between grounded metal and accessible metal or the enclosure shall not be less than 1/16 inch (1.6 mm).

25.3.3 Class 2 circuits

25.3.3.1 Unless required by 25.3.3.2 or 25.3.3.3, spacings in a Class 2 circuit shall not be specified.

25.3.3.2 The spacings between a Class 2 circuit and non-Class 2 circuits, accessible metal, and grounded metal shall not be less than 3/32 inch (2.4 mm).

25.3.3.3 For a safety circuit located in a Class 2 circuit, through-air and over-surface spacings shall not be less than 3/32 inch (2.4 mm) between uninsulated live parts of opposite polarity.

Exception: When short-circuiting between parts where spacings are deficient does not result in unsafe operation of the safety circuit, spacings shall not be specified.

25.4 Spacings on printed wiring boards

25.4.1 Line voltage parts

25.4.1.1 Spacings shall be as specified in 25.3.1.

Exception No. 1: For other than a safety circuit, spacings on a printed-wiring board shall not be less than 1/32 inch (0.8 mm) if the printed-wiring board is potted with an epoxy-based compound or the equivalent, or if the affected traces on the printed-wiring board are covered with a conformal coating as described in 24.3.

Exception No. 2: For other than a safety circuit, opposite polarity spacings in a circuit that is accessible to the occupant or in contact with circulating water are not specified from the point at which the circuit complies with the requirements in 12.8.

Exception No. 3: For a safety circuit, spacings on a printed-wiring board shall not be less than 1/16 inch (1.6 mm) if the printed-wiring board is potted with an epoxy-based compound or the equivalent, or if the affected traces on the printed-wiring board are covered with a conformal coating as described in 24.3.

Exception No. 4: Requirements specified for Clearance and Creepage Distances in the Standard for Industrial Control Equipment, UL 508, are not prohibited from being used.

25.4.2 Class 2 circuits

25.4.2.1 Spacings shall be as specified in 25.3.3.

Exception No. 1: Spacings for a safety circuit shall not be less than 1/64 inch (0.4 mm).

Exception No. 2: Requirements specified for Clearance and Creepage Distances in the Standard for Industrial Control Equipment, UL 508, are not prohibited from being used.

25.5 Spacings within motors

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

25.6 Clearance and Creepage Distances

25.6.1 As an alternative approach to the spacing requirements specified in Spacings, Section 18, and other than as noted in 25.6.2 and 25.6.3, 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 25.6.4.

25.6.2 Clearances between an uninsulated live part and the walls of a metal enclosure, including fittings for conduit or armored cable, shall be as noted in 25.3.1. The clearances shall be determined by physical measurement.

25.6.3 The clearance and creepage distance at field wiring terminals shall be in accordance with 25.2.

25.6.4 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) The installation shall be considered 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) The installation environment shall be considered to be Pollution Degree III except for those product intended for indoor use only. Installations in a garage or the like would also be considered Pollution Degree III.

2) 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;

3) 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;

4) 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.

26 Internal Bushings

26.1 When conductors pass through an opening in a sheet metal wall that is 0.042 inch (1.07 mm) or less thick, they shall be held away from the edges of the opening or shall be guarded by a bushing or a grommet or by rolling the edge of the metal at the opening not less than 120 degrees. A bushing, if used, shall be securely held in place, and an insulating bushing shall not be less than 1/16 inch (1.6 mm) thick with a minus tolerance of 1/64 inch (0.4 mm) for manufacturing variations. The edges of an opening in sheet metal thicker than 0.042 inch shall be treated to reduce the possibility of abrasion of the insulation by the removal of burrs, fins, and sharp edges.

26.2 A fiber bushing shall not be used in a unit through which water is circulated.

27 Gaskets

27.1 A gasket or seal needed to comply with the Water Exposure Test, Section 54, or the Ozone Offgas Test, Section 57, shall, after conditioning, comply with the requirements for tensile strength, elongation, and, if applicable, maximum compression set and tensile set specified in the tests for property profile information table in the Standard for Gaskets and Seals, UL 157.

27.2 A gasket or seal exposed to ozone before the ozone is injected into the water circulating system, or exposed to a fluid other than spa water, in addition to complying with the requirements in 27.1, shall comply with the applicable requirements specified in the test considerations for end-use applications table in the Standard for Gaskets and Seals, UL 157.

28 Thermal Insulation

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

28.2 A polymeric material, such as foam, used as thermal insulation supplemental to the barrier specified in 8.3.4 shall have a minimum flame rating of HB or HBF in accordance with the requirements in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

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

28.4 Determination of the acceptability of an adhesive may be omitted if the thermal insulation is mechanically supported by at least one rivet or equivalent fastening per square foot (9.3 dm^2) of material.

29 Motors

29.1 General

29.1.1 A motor shall be capable of handling the maximum load of the unit as described in 42.1 and 47.1 without increasing the risk of fire or electric shock.

29.1.2 A motor winding shall be such as to resist the absorption of moisture and shall be formed and assembled to be free of loose turns, irregular crossovers, poor ties, and the like.

29.1.3 With reference to the requirement in 29.1.2, film-coated wire is not required to be additionally treated for moisture resistance, but fiber slot liners, cloth coil wrap, and similar moisture-absorptive materials shall be provided with impregnation or otherwise treated for such purpose.

29.1.4 A brush holder assembly shall be constructed so that when a brush is no longer capable of performing its function, the brush, spring, and other parts of the assembly will be retained to the degree necessary to reduce the risk of an accessible dead metal part becoming energized and of a live part becoming accessible.

29.1.5 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) A solid-state control that complies with the Standard for Solid-State Controls for Appliances, UL 244A, is considered to fulfill the Motors Provided With Controls requirements of UL 1004-1. Compliance with the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series fulfills the requirements in UL 244A.

c) See 8.3 of UL 1563 for the applicability of the Frame and Enclosure (nonmetallic) requirements of UL 1004-1.

d) Metal enclosure requirements of UL 1004-1 are superseded by the requirements of Section 8 of UL 1563.

e) Grounding requirements of UL 1004-1 are superseded by the requirements of Section 16 of UL 1563.

f) 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 1563).

g) The Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts requirements of UL 1004-1 is superseded by Section 11 of UL 1563.

h) The Protection Against Corrosion requirements of UL 1004-1 are superseded by Section 13 of UL 1563.

i) 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.

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

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

l) The marking requirements of Section 43 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 Motor circuit overload protection

29.2.1 A unit employing a motor shall incorporate thermal or overcurrent protection that consists of one of the following:

a) Thermal protection complying with the applicable requirements in the Standard for Overheating Protection for Motors, UL 2111; the Standard for Impedance Protected Motors, UL 1004-2; or the Standard for Thermally Protected Motors, UL 1004-3.

Exception No. 1: For a motor that includes a control that limits the length of time the motor can be operated, such as a timer, the duration of the temperature test and the endurance test (both under locked rotor conditions) may be less than that specified but shall be no less than the period of operation permitted by the control.

Exception No. 2: When the time required to operate a manually reset protective device through 10 cycles of operation is longer than the time that the motor is likely to be operated during each use, the number of operations of the device for the temperature test under locked-rotor conditions may be less than 10 cycles but no less than 4 cycles.

Exception No. 3: A motor intended to move air only, by means of an air-moving fan that is integrally attached, keyed, or otherwise fixed to the motor, is not required to have running-overload protection.

b) *Deleted.*

c) *Deleted.*

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

e) Electronic overcurrent protection provided as part of a motor-drive complying with the Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy, UL 61800-5-1. The combination of the motor and the motor drive shall comply with the running overcurrent and locked rotor protection requirements specified in the Standard for Electronically Protected Motors, UL 1004-7;

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

g) Electronic circuits complying with Supplement SB and the tests of the Standard for Thermally Protected Motors, UL 1004-3;

h) Impedance protection complying with the applicable requirements in the Standard for Overheating Protection for Motors, UL 2111, the Standard for Impedance Protected Motors, UL 1004-2, or the Standard for Thermally Protected Motors, UL 1004-3, when the motor is tested as used in the product; or,

i) Other protection that is shown by test to be equivalent to the protection mentioned in (a).

29.2.2 When a requirement in this standard refers to the horsepower rating of a motor and the motor is not rated in horsepower, use is to be made of the appropriate table of the National Electrical Code, ANSI/NFPA 70, that gives the relationships between horsepower and full-load currents for motors. For a universal motor, the table applying to a single phase, alternating-current motor is to be used if the appliance is marked for use on alternating-current only; otherwise the table applying to direct-current motors is to be used.

29.2.3 A thermal or overcurrent protective device shall not open the circuit during the temperature test.

29.2.4 Devices (other than those that are inherent in a motor) employed for motor-running overcurrent protection shall be located in each ungrounded conductor.

29.2.5 A fuse employed for motor-running overcurrent protection shall be located in each ungrounded conductor and in each of the phases of a 3-phase, 3-wire, alternating-current motor.

30 Overcurrent, Thermal, or Overload Protective Devices

30.1 The actuator of a protective device, such as a fuse or circuit breaker, whose functioning requires resetting or replacement shall be in an accessible location.

Exception: The protective device need not 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 its location and the omission of reference to the device in the operating instructions and circuit diagrams.

30.2 A fuseholder shall be constructed and installed so that no uninsulated live part other than the screw shell will be exposed to contact by persons removing or replacing fuses.

30.2.1 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, or

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

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

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

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

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

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.

30.3 The screw shell of a plug-type fuseholder and the accessible contact of an extractor fuseholder shall be connected toward the load.

30.4 An overcurrent- or thermal-protective device shall have a current and voltage rating no less than the load it controls.

30.4.1 Fuses specified in 30.4 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, or

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

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

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

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

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

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

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

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

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

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.

30.4.2 Circuit breaker type overcurrent protections specified in 30.4 shall comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

30.5 A circuit breaker, if used in a 240-volt circuit, shall be a two-pole "common-trip" type (a two-pole circuit breaker that, when one pole is tripped, the other pole is tripped automatically).

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

30.7 For a unit rated more than 20 amperes, each thermally protected motor shall be additionally protected by a branch-circuit-type overcurrent protective device. The branch-circuit overcurrent protective device shall be in series with the ungrounded conductor of each motor. When there is more than one ungrounded conductor for a motor, the branch-circuit protective device shall be located in the conductor which is connected directly to the thermal protector within the motor. The rating of the overcurrent protective device(s) shall correspond to the rating of the fuse used during the original investigation of the thermal protector in the motor.

Exception No. 1: A branch-circuit-type overcurrent protective device may protect more than one motor when:

a) The total electrical load of the motors does not exceed the rating of the overcurrent protective device and

b) The overcurrent protective device is sized in accordance with 30.7 for the current rating of the smallest motor.

Exception No. 2: A branch-circuit-type overcurrent protective device need not be provided for the motor(s) in a unit rated more than 20 amperes if it can be determined that equivalent motor protection is provided by the external overcurrent device that is protecting the branch circuit supplying the unit.

30.8 For a controller with an output intended for a pump or other motor load rated more than 16 amperes, each output shall be provided with a branch-circuit-type overcurrent protective device. The branch-circuit-type overcurrent protective device shall be in series with the terminal or lead intended for the ungrounded conductor of each motor. The rating of the overcurrent protective device (s) shall correspond to 125% of output current rating. If this does not correspond to a standard overcurrent protective device rating, the next highest size shall be used. See 30.12 for standard sizes. The output shall be marked with the range of ratings appropriate for the switching device and the internal branch-circuit overcurrent protection.

30.9 A unit rated more than 20 amperes shall incorporate overcurrent protection rated at no more than 20 amperes for each lighting circuit and for the primary of each transformer, including ozone generator lamp ballasts. The overcurrent protection may be either a branch-circuit-type or a supplementary-type protector.

Exception: Units evaluated for use with overcurrent protection rated more than 20 amperes.

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

Exception: Additional overcurrent protection is not required as a part of the unit for the conductors of the two types of subdivided circuits described in (a) and (b) as follows:

a) For each separate 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) For each separate motor control circuit supplied by insulated conductors having an ampacity at least one-fifth that of the protective device in the branch circuit to which the unit will be connected.

30.11 A unit rated more than 48 amperes shall have an integral overcurrent protective device rated no more than 60 amperes protecting each heating element. The current through each heating element shall not exceed 48 amperes as specified in 21.4.

Exception: The overcurrent protective device may protect more than one load when the total load on the device does not exceed 48 amperes.

30.12 The overcurrent protection mentioned in 30.7 and 30.11 shall be of a type rated for branch-circuit protection. When a fuse is used, it shall be a standard Class CC, G, H, J, K, RK, or T cartridge fuse or Type S or Edison-base plug fuse.

31 Transformers and Power Supplies

31.1 The transformer shall meet the constructional requirements specified in the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and either the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2 or the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3; in the Standard for Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances, UL 1411; or in the Outline of Investigation for Power Units for Fountain, Swimming Pool, and Spa Luminaires, UL 379, or an equivalent set of requirements.

31.2 In addition to the requirement in 31.1, a transformer supplying a circuit that is accessible to the occupant or in contact with circulating water, or a transformer used to power an underwater luminaire as specified in the Exception to 39.1 shall:

a) Be an isolating transformer that has its primary and secondary windings wound on and insulated from separate sections of the core; or

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

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

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

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

31.3 Except as specified in 31.2 (c), (d), and (e), transformers shall comply with the performance requirements specified in the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1, and either the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2, or the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3, or as described in 58.7.1.

31.4 A separate power supply powering an audio/video system shall comply with the performance and constructional requirements specified 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, or in the Standard for Class 2 Power Units, UL 1310.

Exception: A separate power supply that meets the requirements specified in the Standard for Power Units Other Than Class 2, UL 1012, is not required to comply with 31.4 when all the components that it energizes comply with the requirements specified in the Standard for Audio, Video and Similar Electronic Apparatus – Safety Requirements, UL 60065, and the applicable requirements in Audio/Video Components, Section 41.

31.5 The secondary circuit of a transformer supplying a circuit that is accessible to the occupant or in contact with circulating water, or a transformer used to power an underwater luminaire as specified in the Exception to 39.1 shall not be grounded.

31.6 The core of a transformer supplying a circuit specified in 31.5 shall be bonded to the equipment grounding conductor in accordance with Table 31.1.

Table 31.1
Transformer bonding

Construction	Core shall be bonded	Core not prohibited from being bonded
Primary and secondary windings wound on and insulated from separate sections of a core.	X	
Concentrically wound, primary and secondary insulated from and separated by a grounded copper shield at least 0.005 inch (0.127 mm) thick		X
Transformers that comply with UL 1097 or UL 2097		X

31.7 The transformer core is not prohibited from being bonded to the equipment grounding conductor for all transformers not supplying a circuit specified in 31.5.

32 Switches and Controllers

32.1 A switch, relay, or other control device shall be rated for the type, current and voltage, of load that it controls.

32.1.1 Switches shall comply with the Standard for General-Use Snap Switches, UL 20, the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1, or the Standard for Clock Operated Switches, UL 917.

32.1.1.1 Switches that comply with the Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1, shall be rated as specified in 32.1.1.2 – 32.1.1.4.

32.1.1.2 Power switches shall be rated as follows:

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

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

c) For Continuous Duty;

d) With respect to load:

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

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

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

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

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

32.1.1.4 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 Clause 7.1.2.6 of Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1.

32.1.2 Electronic motor drives shall be suitable for the pump voltage and current rating and shall comply with one of the following:

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

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

c) The circuit requirements in Supplement SB.

32.1.2.1 Electronic motor drives that additionally provide motor overload protection shall comply with 29.2.1.

32.1.3 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.

32.2 A through cord switch shall not be used.

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

32.4 A convertible unit or a permanently connected unit shall be provided with an integral disconnect switch that de-energizes power to the entire unit for servicing, maintenance, or the like unless the unit is provided with the statement on the wiring diagram specified in 70.8. The switch shall include a marked "off" position. When accessible to the tub occupant, the switch shall comply with the Exceptions to 32.7.

32.5 A switch provided as part of a unit intended to be connected to a power supply circuit having a potential to ground of more than 150 volts shall be intended for the maximum potential to ground of the circuit.

32.6 A nominal 208-volt, single or 3-phase unit 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 unit 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.

32.7 A switch for a spa shall not be accessible to the tub occupant.

Exception No. 1: A switch may be accessible when it complies with all the following:

a) The switch enclosure is of insulating material;

b) All live parts of the switch, other than terminals, are completely enclosed by the switch enclosure and the switch terminals are not accessible;

c) No dead-metal part that extends outside the switch enclosure enters the chamber within the switch where contact arcing occurs;

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

e) With the exposed external part(s) of the actuator removed in its entirety, no live part inside the switch enclosure is accessible;

f) Metal mounting screws or rivets securing the switch to accessible dead metal of the unit shall not pass through the enclosure of the switch (but may pass through projections of the switch enclosure or through insulating material secured to the switch);

g) A chamber within the switch where contact arcing occurs shall be separated from exposed dead metal by mica no less than 0.005 inch (0.13 mm) thick or by other equivalent insulation; and

h) Metal assembly screws, rivets, clamps, or other switch mounting devices are insulated from dead metal or polymeric material to which the switch is secured.

Exception No. 2: The switch may be accessible when it is located in circuitry that complies with the requirements in 12.8 for circuits that are accessible to the occupant or in contact with circulating water.

32.8 A switch controlling one or more electric heating elements shall be arranged so that opening the switch will de-energize all the elements.

32.9 A general-use snap switch rated for AC/DC use (not marked "AC") that controls an inductive load, such as a transformer or a ballast, shall have a current rating twice that of the load it controls.

32.10 Unless provided with a suitable enclosure, a switch handle, knob, or actuator consisting of a metal insert covered with an exterior layer of insulating material shall be subjected to the Test for Resistance to Impact, Section 56. The results are in compliance when there is no cracking or breaking of the insulating

material (or the inner layer of insulation if there is more than one layer) or dislodging of the handle from its intended position.

32.11 A switch handle, knob, or actuator that consists entirely of insulating material shall be subjected to the Test for Resistance to Impact, Section 56. The results are in compliance when the handle is not dislodged from its intended position.

Exception: The requirement does not apply when, with the handle completely removed from the switch, no live part and no previously inaccessible dead metal is accessible.

33 Capacitors

33.1 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 such that the plates are not subject to mechanical damage and the risk of emission of flame or molten material resulting from malfunction of the capacitor is reduced. The container shall be of metal providing strength equivalent to uncoated steel having an average thickness of 0.020 inch (0.51 mm). Sheet metal having an average thickness less than 0.026 inch (0.66 mm) shall not be used.

Exception No. 1: The individual container of a capacitor may be of thinner sheet metal or may be of material other than metal if the capacitor is mounted in an enclosure that houses other parts of the unit and provided that such a box, case, and the like is rated for the enclosure of current-carrying parts.

Exception No. 2: The individual enclosure of an electrolytic capacitor with means for venting is required to be such as to reduce the risk of mechanical damage only, and the requirement for minimum enclosure thickness does not apply. The individual enclosure of an electrolytic capacitor not provided with means for venting but provided with an opening more than 1/16 inch (1.6 mm) wide between the capacitor enclosure and the motor need not comply with the requirement for enclosure thickness if it complies with 58.6.1.

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

33.3 A capacitor employing a dielectric medium of wax or of liquid other than askarel shall comply with the Standard for Capacitors, UL 810.

34 Lampholders and Receptacles

34.1 A lampholder for a low-voltage (for example, 6-volt) lamp shall not be tapped across a part of a winding of a motor when the rating of the motor is more than 230 volts.

34.2 An ANSI 15- or 20-ampere, 125-volt receptacle shall not be provided.

34.3 Receptacles used as a means to terminate cords between component enclosures (such as cords interconnecting spa controls, pumps, blowers, lights, and similar devices) shall have markings provided in accordance with 72.3.4 and 72.5.2 to indicate the intended load(s), such as a pump or blower, as well as the maximum electrical ratings of the intended load(s).

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

34.5 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.

34A Temperature sensing, thermistor devices

34A.1 A temperature sensing device, such as a positive temperature coefficient (PTC) thermistor and a negative temperature coefficient (NTC) thermistor, that is used in combination with an electronic control and that together with the control provides an operating or protective function shall comply with the Standard for Thermistor-Type Devices, UL 1434.

34A.2 The thermistors described in 34A.1 shall be investigated for:

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

b) Temperature Excursions: Outdoor Use Conditions

34A.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).

35 Temperature-Regulating Controls

35.1 General

35.1.1 A unit provided with an integral heater or provision for a heater shall also be provided with an adjustable water temperature-regulating control.

35.2 User controls – standard settings

35.2.1 The water temperature-regulating control shall have marked temperature settings with no marked water-temperature settings higher than 40°C (104°F).

35.2.2 A unit shall not permit settings that correspond to operating temperature values higher than 40°C (104°F).

Exception: Units that comply with the special temperature settings requirements in 35.3.1 – 35.3.4.

35.2.3 Water temperature-regulating controls shall be factory adjusted to a temperature setting corresponding to an operating temperature value of no more than 38°C (100°F).

35.3 User controls – special temperature settings

35.3.1 In accordance with the Exception to 35.2.2 units are not prohibited from having special temperature settings to allow higher operating temperature values for thermal loss compensation.

35.3.2 The maximum special temperature setting shall correspond to an operating temperature value of no more than 41°C (106°F) and shall only be obtained through a special input to the control by the user. The user actuation mechanism shall be such that it is highly unlikely these settings could be accidentally accessed.

35.3.3 The maximum operating temperature value of the water temperature-regulating control shall reset to 40°C (104°F) if the user reduces the setting to one corresponding to 40°C or less.

35.3.4 There shall be a visible indication when a unit's special temperature setting feature has been activated.

35.4 Water temperature indication

35.4.1 A unit shall be provided with an indicator that displays the actual temperature of the tub water. The indicator is not prohibited from being a device separate from the water temperature regulating control. If provided as a separate device, it shall have means to reliably attach it to the spa at a location specified by the manufacturer.

35.4.2 The temperature indicator shall have a maximum tolerance of ± 2° F (± 1° C) and shall be graduated in increments no greater than ± 2°F.

35.5 Construction

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

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

a) The water heater control requirements in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873. In addition, the control shall have a maximum tolerance of ± 3°C (± 5° F) and shall comply with the calibration verification and 100,000-cycle endurance requirements in UL 873. If part or all of the control is electronic, it shall comply with 37.6, 37.7 and Appendix B.

b) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, with the parameters as specified in Table 35.1.

c) The circuit requirements in Supplement SB.

Table 35.1
Temperature-regulating control parameters

UL 60730-1, Table 7.2DV item number	Information	Control requirement
6	Purpose of control	Operating Control
7	Type of load controlled	AC heater load
27	Number of Automatic cycles (A)	100,000
29	Type of disconnection or interruption	Micro-Disconnection
36	Limits of Activating Quantity	40°C (104°F) setpoint normal operation 41°C (106°F) setpoint special settings per 35.3
39	Type 1 or Type 2 action	Type 2
40	Additional features	Automatic reset
41	Manufacturing Deviation, maximum	±3°C (±5°C)
42	Drift	Not vary from the as-received temperature by more than 5 percent of the Fahrenheit setpoint temperature, or

Table 35.1 Continued on Next Page

Table 35.1 Continued

UL 60730-1, Table 7.2DV item number	Information	Control requirement
		by more than 10°F (6°C), whichever is the greater.
49	Pollution degree	Pollution degree 3
52	The minimum parameters of any heat dissipater (heat sink) not provided with an electronic control but essential to its correct operation	Must be specified
53	Output waveform if other than sinusoidal	Must be specified
58a	Required protection/immunity from mains borne perturbations, magnetic and electromagnetic disturbances	Required[a]
69	Software Class	B
74	External load and emission control measures to be used for test purposes	Intended heater
90	Surge immunity	IEC 61000-4-5 installation Class 3. Overvoltage category II.
92	Class of Control Function	B

[a] For the purpose of the tests specified in Annex H, Section 26 of UL 60730-1, the products covered by this Standard should be considered as:

a) Installation Class 3 (See Annex R, UL 60730-1);

b) Overvoltage Category III

c) Test Level 3

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

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

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

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

36 Temperature-Limiting Controls

36.1 A unit shall be provided with a temperature-limiting control that:

a) Limits the water at the inlet to the tub to a maximum temperature of 50°C (122°F),

b) Is in addition to any temperature-regulating control(s),

c) Opens all ungrounded power supply conductors in the heater circuit, and

d) Has a tolerance at the maximum temperature setting of not more than ±3°C (±5°F).

36.2 A temperature-limiting control shall be either a manually resettable type with a defined state (hard lockout) or a thermal link.

36.3 A manually resettable control shall be trip free in accordance with 36.5, and the means for resetting shall be readily accessible to the user. Such a control shall comply with the requirements in a, b, c or d below.

a) The Standard for Limit Controls, UL 353.

b) The water heater limit control requirements in the Standard for Limit Controls, UL 353, or the water heater limiting control requirements in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873. Its reset mechanism shall be "Manually Reset 2" or "M2". If part or all of the control is electronic, it shall comply with 37.6, 37.7 and Appendix B.

c) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, with the parameters as specified in Table 36.1.

d) The circuit requirements in Supplement SB.

Table 36.1
Temperature-limiting control parameters

UL 60730-1, Table 7.2DV item number	Information	Control requirement
6	Purpose of control	Manually Reset Thermal Cut-Out
7	Type of load controlled	AC heater load
27	Number of Automatic cycles (A)	6000: 1000 with load 5000 without load
29	Type of disconnection or interruption	Full-Disconnection
36	Limits of Activating Quantity	50°C (122°F) setpoint
39	Type 1 or Type 2 action	Type 2
40	Additional features	Manual Reset, Type 2.D.J Action
41	Manufacturing Deviation, maximum	±3°C (±5°C)
42	Drift	Not vary from the as-received temperature by more than 5 percent of the Fahrenheit setpoint temperature, or by more than 10°F (6°C), whichever is the greater.
49	Pollution degree	Pollution degree 3
52	The minimum parameters of any heat dissipater (heat sink) not provided with an electronic control but essential to its correct operation	Must be specified
53	Output waveform if other than sinusoidal	Must be specified
58a	Required protection/immunity from mains borne perturbations, magnetic and electromagnetic disturbances	Required[a]
69	Software Class	B
74	External load and emission control measures to be used for test purposes	Intended heater

Table 36.1 Continued on Next Page

Table 36.1 Continued

UL 60730-1, Table 7.2DV item number	Information	Control requirement
90	Surge immunity	IEC 61000-4-5 installation Class 3. Overvoltage category II.
92	Class of Control Function	B
[a] For the purpose of the tests specified in Annex H, Section 26 of UL 60730-1, the products covered by this Standard should be considered as: a) Installation Class 3 (See Annex R, UL 60730-1); b) Overvoltage Category III c) Test Level 3		

36.4 A thermal cutoff shall comply with the Standard for Thermal-Links – Requirements and Application Guide, UL 60691.

36.5 With reference to 36.3, the term "trip free" means that the device is constructed so that the contacts cannot be held in the closed position when the water has attained a temperature hotter than specified, regardless of the position of the actuating handle, button, lever, or the like.

36.6 With reference to 36.1(c), either a single-pole device or a multipole device may be used when there is one pole in each ungrounded power supply conductor. The requirement is applicable regardless of the number of power supply circuits used.

36.7 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 employed 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.

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

36.9 When opening of the control circuit makes the limit control inoperative, it shall also result in opening the electrical supply to the heater.

36.10 Shorting of the limit control circuit to ground shall not make the limit control inoperative.

36.11 Dry-fire protection shall be provided to reduce the risk of damage to the heater or adjacent parts when there is no water flow through the heater. Compliance with this requirement shall be determined by the test described in 58.1.1.

36.12 A water-sensing device, when used as the dry-fire protection specified in 36.11, shall be installed in such a way as to reduce the risk of contamination due to hair, dirt, calcium deposits, and the like.

37 Reduction of Risk of Injury to Persons

37.1 General

37.1.1 When an automatic-reset type of protective device is employed in a unit, the automatic restarting of the motor shall not result in any risk of injury to persons.

37.1.2 The requirement in 37.1.1 necessitates the use of an interlock in the pump when any moving part or the like would be likely to present a risk of injury upon automatic restarting of the motor.

37.1.3 An edge, projection, or corner of an enclosure, opening, frame, guard, handle, or the like shall be smooth and well-rounded and shall not cause a laceration or cut-type injury during use or maintenance.

37.1.4 Any moving part, such as a rotor of a motor, a pulley, a belt, or a gear, shall be enclosed or guarded to reduce the risk of injury to persons.

37.1.5 With reference to the requirement in 37.1.4, the degree of protection required of the enclosure depends upon the general design and intended use of the unit. The factors to be taken into consideration in evaluating the acceptability of an exposed moving part are:

a) The degree of exposure;

b) The sharpness of the moving part;

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

d) The speed of movement of the part; and

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

37.1.6 In addition to complying with 37.1.4 and 37.1.5 and under normal operating conditions, a moving part coming into contact with the occupant shall not exert a force greater than 7 pounds (9.49 J). When the mechanism (moving part) is motorized, it shall reverse its direction of motion when it encounters a resistance greater than 7 pounds.

37.1.7 When the weight of the moving part referenced in 37.1.6 (including the weight of the supported component and the supporting structure) exceeds 7 pounds, then it shall additionally comply with the static loading test in the Structural Integrity Tests, Section 62.

37.2 Stability

37.2.1 A cord- and plug-connected unit shall be provided with a base of such dimensions that the unit will not tip over while inclined in any direction at 10 degrees to the horizontal, with or without water load.

37.2.2 Ordinarily, the stability of a spa is to be investigated only when the height of the tub exceeds twice the smallest dimension of the base.

37.3 Risk of scald injury

37.3.1 A unit shall not produce excessive temperatures in water discharged into the tub due to residual heat in a heater during temporary loss of power or reduced or interrupted water flow through the heater as determined by the tests described in 58.2.1 and 58.3.1.

37.4 Heater protection

37.4.1 Water-flow sensing circuitry or devices designed to sense the lack of water when heaters are energized (sometimes called dry-fire protection) shall be investigated for reliability. These devices shall comply with either a, b, c, d or e below:

a) The Standard for Limit Controls, UL 353.

b) The water heater control requirements in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873. In addition, the control shall comply with the calibration verification and 100,000-cycle endurance requirements in UL 873. If part or all of the control is electronic, it shall comply with 37.6, 37.7 and Appendix B.

c) The Standard for Automatic Electrical Controls for Household and Similar Use, 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 Table 37.1.

d) The Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, with the parameters as specified in Table 37.1.

e) The circuit requirements of Supplement SB.

Table 37.1
Water-flow control parameters
(Dry-fire protection)

UL 60730-1, Table 7.2DV item number	Information	Control requirement
6	Purpose of control	Protective control (temperature)
7	Type of load controlled	AC heater load
27	Number of Automatic cycles (A)	100,000
29	Type of disconnection or interruption	Micro-Disconnection
36	Limits of Activating Quantity	Factory pressure, vacuum or temperature setting
39	Type 1 or Type 2 action	Type 2
40	Additional features	Automatic reset
41	Manufacturing Deviation, maximum	The operating pressure of a pressure control shall be within ±5 percent of its set point pressure ±3°C (±5°F) for temperature sensitive controls.
42	Drift	The operating pressure shall not vary from the operating pressure initially determined by more than 5 percent of the maximum set point pressure. Not vary from the as-received temperature by more than 5 percent of the Fahrenheit setpoint temperature, or by more than 10°F (6°C), whichever is the greater.
49	Pollution degree	Pollution degree 3

Table 37.1 Continued on Next Page

Table 37.1 Continued

UL 60730-1, Table 7.2DV item number	Information	Control requirement
52	The minimum parameters of any heat dissipater (heat sink) not provided with an electronic control but essential to its correct operation	Must be specified
53	Output waveform if other than sinusoidal	Must be specified
58a	Required protection/immunity from mains borne perturbations, magnetic and electromagnetic disturbances	Required[a]
69	Software Class	B
74	External load and emission control measures to be used for test purposes	Intended heater
90	Surge immunity	IEC 61000-4-5 installation Class 3. Overvoltage category II.
92	Class of Control Function	B

[a] For the purpose of the tests specified in Annex H, Section 26 of UL 60730-1, the products covered by this Standard should be considered as:

a) Installation Class 3 (See Annex R, UL 60730-1);

b) Overvoltage Category III

c) Test Level 3

37.5 Water backflow

37.5.1 A spa shall be provided with two separate and independent means to prevent water backflow into electrical equipment (such as a backflow loop and a check valve).

Exception No. 1: A spa may be provided with a single component to prevent water backflow into electrical equipment when the results of an investigation indicate that the reliability of the single component is suitable for the application.

Exception No. 2: Water-sanitizing equipment, such as an ozone generator, need only be provided with one backflow check valve.

37.5.2 When a spa or an equipment assembly is tested in accordance with 58.4.1, there shall be no wetting of live parts or electrical insulation.

37.5.3 A check valve provided to reduce the risk of water backflow shall close when the air pressure falls below that pressure represented by the maximum head of water that the valve can be subjected to under any condition of filling. The valve shall not leak when subjected to twice the maximum water pressure, as described in 58.5.1.

37.5.4 When an equipment assembly is provided with a check valve that is necessary to reduce the risk of backflow of water from a hot tub or spa furnished in the field, it shall close when the air pressure falls below the maximum pressure that the blower can develop and shall not leak at any water pressure from zero to 5 pounds-force per square inch (0 to 34.5 kPa), as described in 58.5.1.

37.5.5 A blower or an equipment assembly with a blower shall be provided with the marking specified in 72.4.1 and the instructions specified in 74.5.1.

Exception: A blower or an equipment assembly with a blower that complies with the requirement specified in 37.5.1 is not required to be provided with the marking specified in 72.4.1 and the instructions specified in 74.5.1.

37.6 Safety controls and safety circuits

37.6.1 A temperature-limiting control, a temperature-regulating control, and a dry-fire control are considered to perform a safety function. A component, such as a switch or relay, or an electronic circuit that is used to perform a safety function shall not be used to perform any other function.

Exception: Except as specified in 36.8, an individual component or an electronic circuit may be used to perform functions (including additional safety functions) in addition to the primary safety function if the results of an investigation indicate that the reliability of components in such multiple functions is suitable for the application.

37.7 Reliability

37.7.1 A component investigation (see 58.8.1) shall be necessary when evaluating:

a) Safety controls,

b) Safety circuits,

c) Circuits that are accessible to the occupant or in contact with circulating water, and

d) Other circuits where component faults result in a risk of fire, electric shock, or injury to persons.

37.7.2 Except for controls evaluated in accordance with the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1, 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, and the Standard for Automatic Electrical Controls for Household and Similar Use, Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9, with the parameters as specified in Table 35.1, Table 36.1, and Table 37.1, an electronic or solid-state circuit that performs a backup, limiting, or other function intended to reduce the risk of fire, electric shock, and/or injury to persons, including temperature-regulating, temperature-limiting and dry-fire protection, shall comply with the requirements in Appendix B.

37.7.3 For the purposes of determining circuit reliability required by 37.7.2, the Critical Failure Modes for each type of control are as follows:

a) Temperature-Regulating Control –

1) Normal use set point higher than 40°C (104°F)

2) Special Use Set Point higher than 41°C (106°F)

3) Maximum water temperature exceeding 43°C (109°F)

b) Temperature – Limiting Control – Water temperature at the inlet to the spa greater than 50°C (122°F)

c) Heater Protection – Heater allowed to activate without water flow.

37.8 Ozone generators

37.8.1 An ozone generator provided as an integral spa component 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.

37.8.2 A spa 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 57.

37.8.3 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.

37.8.4 Factors to be taken into consideration when evaluating the acceptability of water disinfection components such as ozone generators include but are not limited to:

a) Type of injection method, including injection depth;

b) Type of injector used, such as an ozone jet or a negative pressure venturi;

c) Contact distance (with water) from the point of generation to the point of injection; and

d) Other factors that may contribute to reduce the off-gassing effects, such as plumbing diameter, type of tubing used, etc.

37.9 Button or coin cell batteries of lithium technologies

37.9.1 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.

Exception: UL 4200A is not applicable to appliances and accessories under the scope of UL 1563 that meet the following:

a) The battery is not intended to be replaced.

b) The battery is not referenced in the instructions or markings.

c) A battery access door or cover is not provided.

d) The appliance or accessory is not intended to be handheld during normal operation.

38 Suction Openings

38.1 Each spa shall be provided with a minimum of two suction openings, or one suction opening and a skimmer equipped with a vacuum break. The suction openings may be shared by more than one pump, provided each pump can draw water from two or more openings. Each suction opening shall be provided with a means to reduce the risk of entrapment. Each suction opening provided for this purpose shall:

a) Have a flow rate in gallons-per-minute (GPM) which equals or exceeds the water flow rating of the specific opening when tested as described in 59.1;

b) Comply with the applicable requirements specified in the Standard Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, and Hot Tubs, APSP-16; and

c) Not be installed on seating or lounge areas or on the backrest(s) of such areas.

Exception: A fitting with no marked flow rating need not comply with 38.1 (a) if it complies with all the provisions of APSP-16 when installed in the spa. Controls shall be adjusted for the maximum water flow through the fitting.

38.2 A suction opening that presents a risk of injury due to its shape, location or intended use under normal or abnormal use, or when it can be used as a seat, step, or support structure facilitating entry or exit from the spa, shall comply with the applicable tests in Structural Integrity Tests, Section 62.

Exception: Small parts unlikely to be subjected to the loading effects anticipated by the tests in Section 62 may be subjected to the Test for Resistance to Impact, Section 56.

38.3 All parts removable without the use of tools shall be removed while the system is evaluated for risk of body and hair entrapment if doing so results in the worst case.

38.4 Additional factors to be taken into consideration when evaluating the acceptability of suction openings not completely submerged (or unlikely to be completely submerged) at all times when installed as intended include but are not limited to:

a) Resistance to impact;

b) Mechanical strength;

c) Normal and abnormal loading effects (such as an occupant using it as a step or seat);

d) Risk of injury (such as a laceration, or the risk of tub occupant inadvertently hitting the device); and

e) The impact of the occupant not replacing some or all removable parts.

38.5 Suction openings shall be installed in such a manner that it is unlikely both suction openings or a suction opening and skimmer on the same pump can be simultaneously blocked. The installed fitting(s) and skimmer shall comply with the body entrapment requirements specified in the Standard for Standard Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, and Hot Tubs, APSP-16.

Exception No. 1: Constructions where the spa is provided with features, electrical, mechanical, or both that release the pump vacuum in the event both fittings on a single pump are blocked. The functionality of these features shall be evaluated by the Body Entrapment Test in APSP-16. Mechanical or electrical construction features necessary for the function of the system shall be evaluated for reliability.

Exception No. 2: Suction outlets protected by either (1) a suction-limiting vent system with a tamper-resistant atmospheric opening or (2) or gravity drainage system.

38.6 Installations specified below are considered unlikely to be simultaneously blocked:

a) One fitting in a footwell and a skimmer.

b) Fittings installed on the same plane and separated by a minimum of 3 feet (0.9 m).

c) Fittings on the same pump that are installed in a footwell where the footwell cannot be completely covered by the 18 inch by 23 inch (457 mm by 584 mm) blocking element specified in APSP-16. In constructions where this cannot be readily determined, the footwell shall be subjected to the Body Entrapment Test specified in APSP-16.

38.7 Suction openings that draw water from a gravity-fed water reservoir are not required to comply with the requirements in 38.3 – 38.6 when they are inaccessible to the occupant, and do not present a risk of hair or body entrapment.

38.8 Skimmers represented by the general descriptions in (a) – (c) and conforming to the overall general shapes and designs (or the equivalent) illustrated in Figure 38.1 – Figure 38.3 are not required to comply with the requirements in 38.3 – 38.6.

a) Weir Door Style Skimmer – A vertically-mounted, square-shaped skimmer installed in the side wall of the spa shell provided with a square-shaped face opening measuring approximately 5 x 5 inches (12.7 x 12.7 cm) or having an opening measuring 25 inches^2 (63.5 cm^2) minimum, installed close to the tub rim. Provided with a weir door for skimming floating debris from the water surface. Provided with a skim basket with mesh openings covering the entire basket. May be provided with a filter cartridge. See Figure 38.1 for the general shape and design of a weir door style skimmer.

b) Floating Weir Style Skimmer – A horizontally-mounted, circular-shaped skimmer measuring approximately 15 inches (38 cm) tall with an 8-inch (20.3 cm) diameter. Installed so that the telescoping floating weir comes within a couple of inches of the tub rim when fully extended. Installed in a recessed area. Provided with an adjustable, telescoping floating weir (extendable to approximately 5 inches) for skimming floating debris from the water surface. Provided with a vacuum break ring. The vacuum break ring is part of the skimmer body, and is provided with the following openings around the diameter of the skimmer allowing water to flow into the skimmer from the sides in addition to the top.

1) Six openings measuring 2 inches (5 cm) wide by 0.25 inches (51 mm) high; or

2) Eight openings measuring 1.15 inches (2.9 mm) wide by 0.2 inches (5 mm) high, and two openings measuring 2.15 inches (5.4 cm) long by 0.2 inches high; or

3) Four openings measuring 2 inches wide by 0.3 inches (8 mm) high, and two openings measuring 1.6 inches (40 mm) wide by 0.3 inches high; or

4) A minimum of six openings evenly distributed along the diameter of the skimmer body having a total area of minimum 2.7 inches^2 (6.8 cm^2).

Provided with a circular-shaped skim basket with mesh openings covering the entire basket. Skim basket and floating weir are held inside the skimmer using friction fit. Provided with a filter cartridge measuring approximately 12 inches (30.5 cm) long. See Figure 38.2 for the general shape and design of a floating weir style skimmer.

c) Strip Style Skimmer – A vertically-mounted, rectangular-shaped skimmer installed in the side wall of the spa shell. Two-piece construction (faceplate and threaded back plate). Overall dimensions approximately 9 inches (23 cm) tall by 4 inches (10 cm) wide by 1 inch (25.4 mm) deep. Installed as close to the tub rim as practical (within a couple of inches). Provided with a half-inch plumbing connection attached to the threaded back plate. Faceplate is screwed to the threaded back plate and is provided with multiple openings having a total area of approximately 7 inches^2 (17.7 cm^2) for skimming floating debris from the water surface. Additional openings are provided either on the tapered sides of the faceplate, or on the threaded back plate having a total area of approximately 3 inches^2 (7.6 cm^2). See Figure 38.3 for the general shape and design of strip style skimmer.

Figure 38.1

Weir door style skimmer

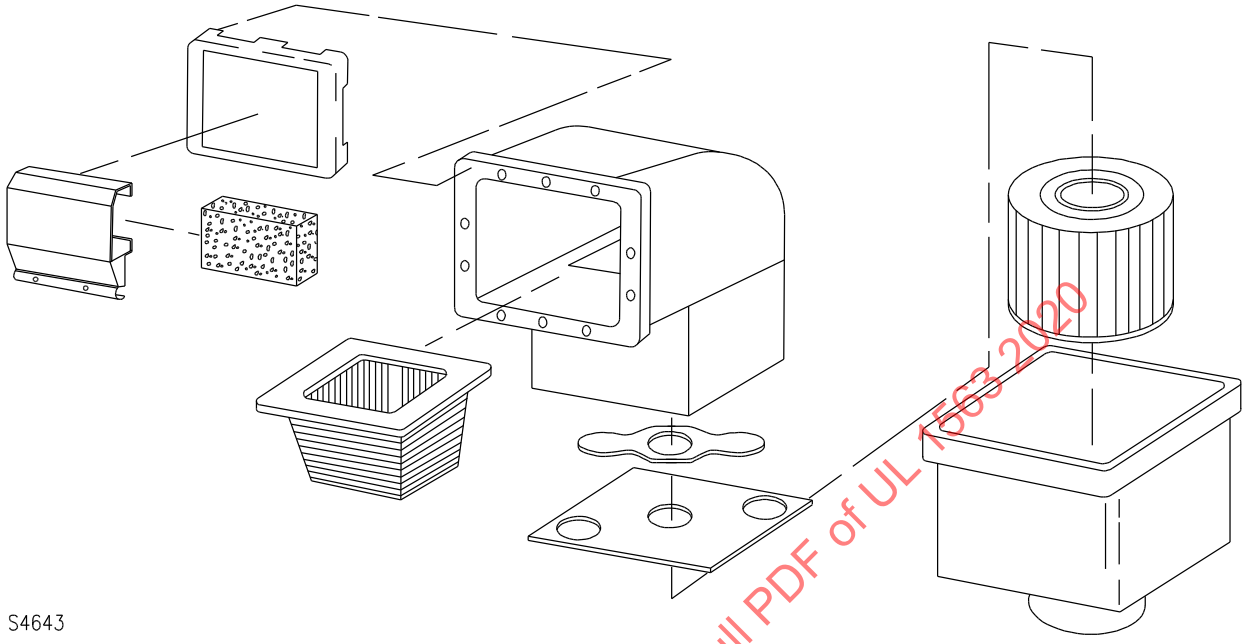


Figure 38.2

Floating weir style skimmer

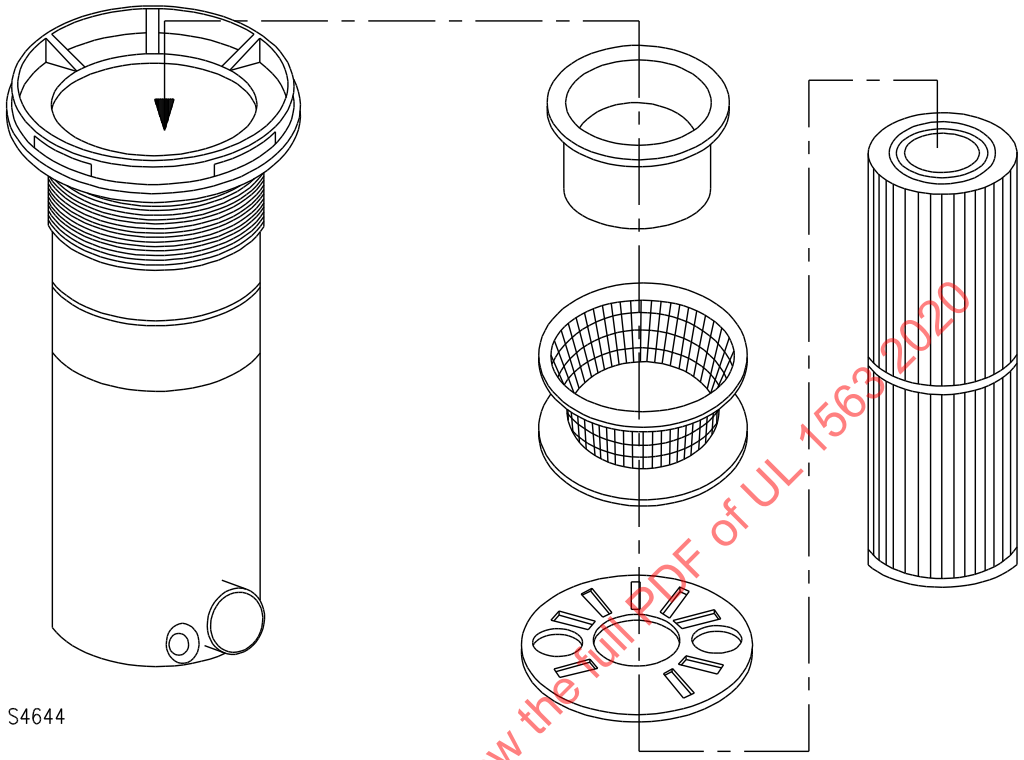
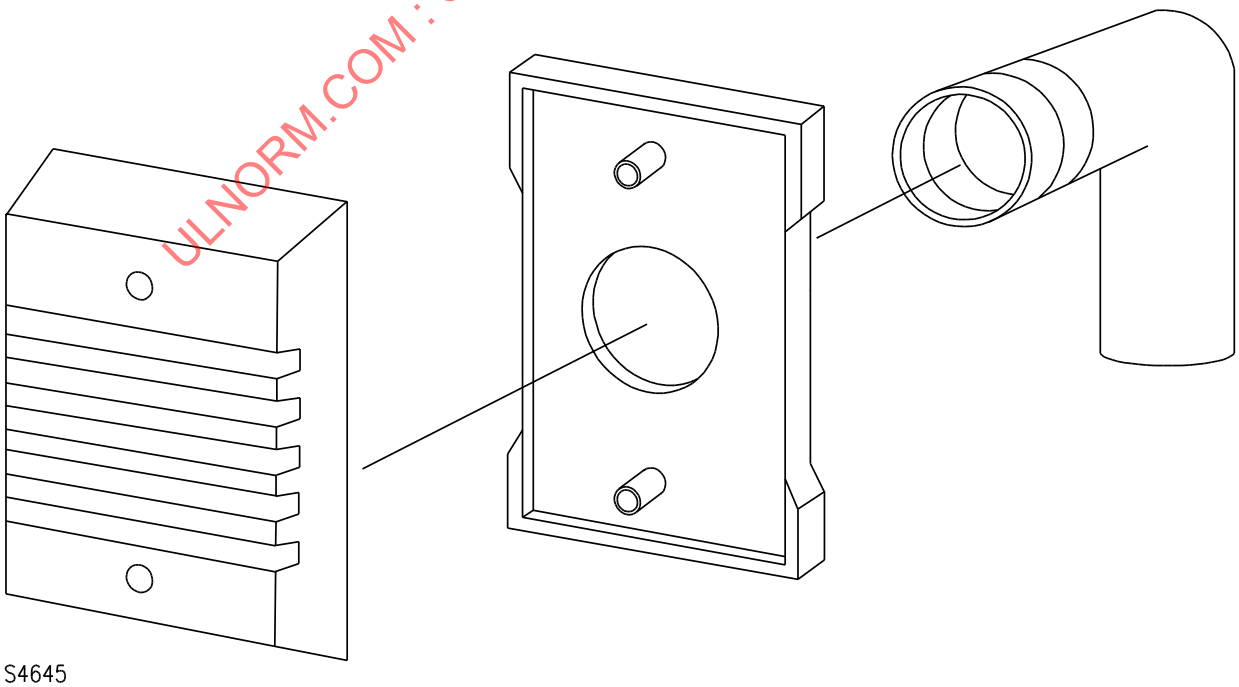


Figure 38.3

Strip style skimmer



38.9 Skimmers shall be of such a design that it is unlikely all openings could be simultaneously blocked. Skimmers shall have additional openings in the skimmer design or in the plumbing system that vent to the atmosphere should the main intake become blocked.

39 Ground-Fault Circuit-Interrupters

39.1 Each permanently-connected unit incorporating a luminaire circuit, each cord- and plug-connected unit, and each convertible unit shall be protected by an integral ground-fault circuit-interrupter that complies with the requirements for a Class A ground-fault circuit-interrupter in the Standard for Ground-Fault Circuit-Interrupters, UL 943.

Exception: Integral ground-fault circuit-interrupter protection is not required for a permanently connected unit incorporating a luminaire circuit provided the luminaire circuit operates at 15 volts AC, or less, and is supplied by an isolating transformer which complies with the transformer construction requirements specified in Transformers and Power Supplies, Section 31.

39.2 When provided, a ground-fault circuit-interrupter shall be a type capable of detecting an open circuit in any line conductor or in the neutral conductor or be a type capable of operating as intended with an open circuit in any line conductor or in the neutral conductor.

Exception: Open neutral protection may be provided by circuitry other than the ground-fault circuit-interrupter when the circuits or components providing open neutral protection comply with the reliability requirements for safety circuits and with the Standard for Ground-Fault Circuit-Interrupters, UL 943.

39.3 When provided, a ground-fault circuit-interrupter (including any external open-neutral circuitry) shall be connected between the supply lead or terminal connections or the attachment plug of a cord-connected unit and all other electrical conductors and equipment. This determination is to be made with the unit connected in all intended voltage configurations.

Exception No. 1: For a convertible unit that incorporates the ground-fault circuit-interrupter in the attachment plug of the power supply cord, the ground-fault circuit-interrupter need not be connected between the supply lead or terminal connections and equipment when the unit is connected in the 240 V mode. The wiring diagram marking specified in 70.8 shall be provided.

Exception No. 2: For a unit with more than one supply circuit, the ground-fault circuit interrupter need not protect both circuits if the wiring diagram marking specified in 70.9 is provided.

39.4 A ground-fault circuit-interrupter shall open all ungrounded and grounded (neutral) conductors in the circuit.

Exception: When the unit is permanently connected (not cord-connected or convertible), the ground-fault circuit-interrupter need not open the grounded conductor.

39.5 A control intended to power or switch an underwater luminaire shall include a ground-fault circuit-interrupter to protect the underwater luminaire circuit.

Exception: A control intended to power or switch a field-installed underwater luminaire that complies with the Standard for Underwater Luminaires and Submersible Junction Boxes, UL 676, is not required to be provided with integral ground-fault protection. When integral GFCI protection is not provided, the unit shall be marked in accordance with 72.3.4 or 72.5.2, as applicable, to indicate that GFCI protection shall be provided in the field.

39.6 In a control or in an equipment assembly, intended to control field installed underwater lighting, the conductors on the load side of the ground-fault circuit-interrupter provided to protect an underwater lighting circuit shall not occupy boxes or enclosures containing other conductors unless the additional conductors are also protected by a ground-fault circuit-interrupter.

Exception: Conductors on the load side of a ground-fault circuit-interrupter provided to protect an underwater lighting circuit may occupy the same boxes or enclosures as other conductors if the conductors are separated by a barrier or if the conductors are segregated, routed, or secured to provide permanent spacing from all other insulated or uninsulated live parts.

39.7 An enclosure for a control or equipment assembly that contains terminals or conductors on the load side of a ground-fault circuit-interrupter provided to protect the field-installed conductors of an underwater lighting circuit shall be marked as specified in 72.3.3 or 72.5.1, as applicable, to indicate that the field conductors shall not occupy conduit, boxes, or enclosures with the conductors of other circuits unless all other conductors are also on the load side of a ground-fault circuit-interrupter.

39.8 A ground-fault circuit-interrupter test button shall be accessible without the use of tools.

40 Pump Shut-Off Devices

40.1 Vacuum-sensing or pump shut-off devices (and systems) are not to be relied upon to prevent hair and body entrapment. These devices are considered to supplement and serve as backup to the suction opening requirements as specified in Suction Openings, Section 38.

40.2 Vacuum-sensing or pump shut-off devices (and systems) shall be evaluated to ensure that their presence does not introduce a risk of fire, electric shock, and/or injury to persons.

40.3 The installation instructions and operation manuals (including marketing brochures and literature) for such devices shall not make the claim (explicit or implied) that these are lifesaving devices and/or systems.

40.4 The installation instructions and operational manual of products equipped with vacuum-/pressure-sensing devices are not prohibited from being marked with other performance-related claims when these claims can be objectively verified.

40.5 When provided, such devices and/or systems shall be identified as part of the configuration sheet as required by 73.8.

41 Audio/Video Components

41.1 Audio/video components shall not be accessible to the occupant as defined in 5.3.

Exception No. 1: Audio components (such as a radio, cassette player, CD player) may be located within 5 feet (1.52 m) of the tub water, when:

a) The component(s) do not present a risk of electric shock as defined in 5.22; or

b) The component(s) are equipped with barriers (or the equivalent) so that the user will need to exit the spa to actuate the controls and the maximum output voltage of the transformer or power supply (as referenced in 31.4) regardless of load with rated input applied, shall not be greater than 30 volts for continuous DC, or 15 volts for sinusoidal AC; or

c) The component(s) are equipped with interlock switch(es) where, by opening the covers, doors, or similar parts to operate the unit, the component presenting a risk of electric shock is de-

energized. The interlock switch shall be located in a manner where it is not likely to be defeated by the user. Additionally, there shall be no reference to the presence of the interlock switch in the user and/or operation manual.

Exception No. 2: Speakers may be located within 5 feet (1.52 m) of the tub water, when the construction complies with (a) – (h). See Figure 41.1.

a) The speaker cone (diaphragm), spider, surround and dust cap is of a non-porous polymeric material,

b) Speaker terminals are enclosed or otherwise sealed to prevent water from contacting them,

c) The speaker coil is enclosed or potted,

d) The speaker grille complies with the barrier requirements specified in 8.3.4. After the impact specified in Test for Resistance to Impact, Section 56 the grille shall continue to comply with g below,

e) The speaker grille is not removable without the use of tools,

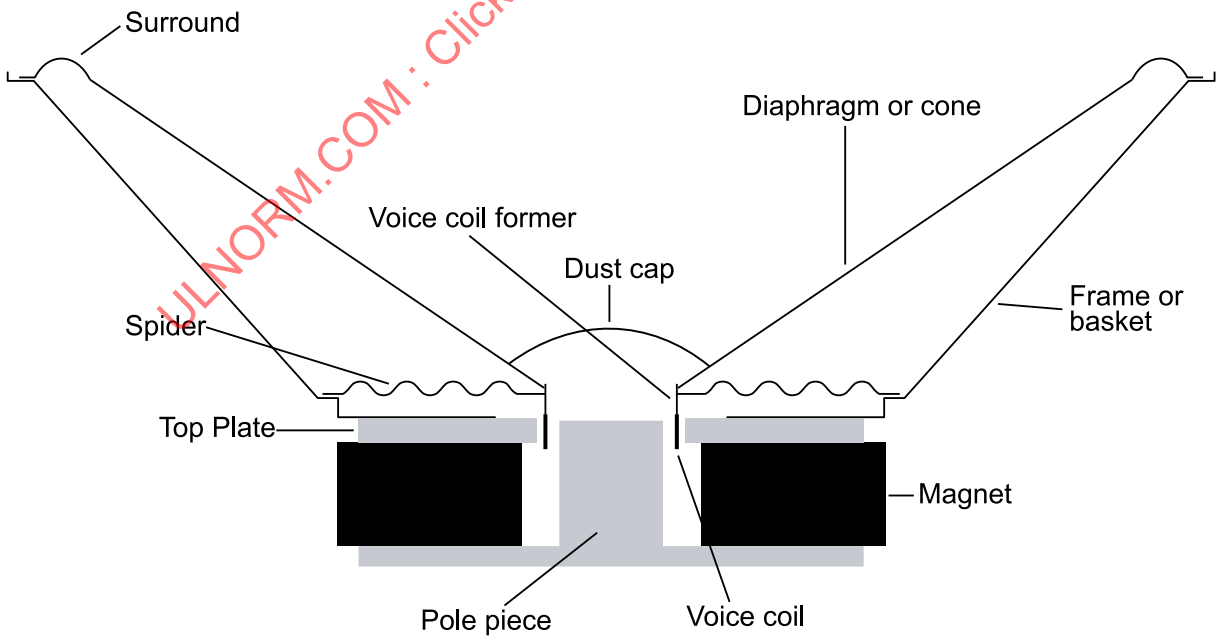
f) The speaker grille has a minimum flammability of HB,

g) The speaker grille renders the speaker cone, surround and dust cap inaccessible to the probe specified in Figure 11.1, and

h) The frame or basket is either polymeric that complies with a and f above or is of metal that complies with Resistance to Corrosion, Section 13.

Figure 41.1

Cross section of speaker driver (grille removed)



41.2 Doors, covers, or similar parts serving as barriers or providing weather protection shall be of self-closing type.

41.3 A video component such as a television shall be located behind a permanent barrier(s) that requires use of a tool(s) to access the component. The barrier(s) shall serve as a secondary electrical enclosure to completely enclose the video component.

41.4 A video component shall not have any controls accessible to the occupant.

Exception: A control may be accessible to the occupant when it does not present a risk of electric shock as specified in 5.22, and complies with the Available Current Test, Section 44.

41.5 Wireless remote controls provided to operate the audio/video components shall:

a) Not present a risk of electric shock as determined by the Available Current Test, Section 44;

b) Be provided with two independent layers of electrical and mechanical isolation; or

c) Operate on 4.5 VDC or less.

41.6 A barrier(s), as required in 41.3, shall comply with the nonmetallic enclosure requirements in 8.3.1, 8.3.3, and 8.3.4. In addition:

a) The inside surface of the secondary enclosure shall be spaced not less than 1/2 inch (12.7 mm) from the primary enclosure;

b) The enclosure shall not be less than 3/16 inch (4.8 mm) thick;

c) The enclosure shall be constructed and mounted so that the possible mechanical abuse to which it will be subjected to during normal use is minimized; and

d) The enclosure shall comply with the applicable Structural Integrity Tests, Section 62.

Exception: Small parts that are unlikely to be subjected to the loading effects anticipated by the Structural Integrity Tests shall be subjected to the Test for Resistance to Impact, Section 56.

41.7 Audio/video components shall be located above the "flood zone", where they are unlikely to be submerged in the event the spa is overfilled (or similar abnormal condition occurrence).

41.8 The location, orientation, and intended use of the audio/video components shall be evaluated to ensure that they do not adversely affect the safety of other electrical components as determined by the Water Exposure Test, Section 54. Examples include, but are not limited to, water dripping from the speaker cones, openings that may be created as a result of a moving component, or the like.

41.9 No provision shall be provided for connecting auxiliary components, such as additional speakers, headphones, external antennae, cable providing radio or TV signals, or similar components.

Exception No. 1: Headphones, internal antennae, or similar devices may be provided with the system when they do not present a risk of electric shock as specified in 5.22, and comply with the Available Current Test, Section 44.

Exception No. 2: A spa may have provision for connecting portable battery powered audio/video players when the connecting mechanism meets the requirements of 41.1.

41.10 Audio/video components shall be identified as part of the configuration sheet as required by 73.8.

41.11 Any exposed dead metal used as part of the audio/video system or supporting structure shall be bonded to the equipment grounded conductor.

PERFORMANCE

42 General

42.1 All tests shall be conducted with the unit connected to a supply circuit of rated frequency at a voltage indicated in Table 42.1.

Table 42.1
Test voltages

Rated voltage of appliance	Test voltage
1. A single voltage within any of the nominal ranges: 110 – 120, 220 – 240.	The highest voltage of the nominal range
2. A range of voltages, the highest of which falls within one of the ranges of (1).	The highest voltage of the nominal range
3. A single voltage, not within any of the ranges of (1).	The rated voltage
4. A range of voltages, the highest of which is not within one of the ranges of (1).	The highest voltage of the rated range

42.2 A permanently connected unit, or a convertible unit when tested for permanent connection, shall be connected to the supply using copper conductors sized in accordance with Table 15.2.

42.3 A cord-connected unit or a convertible unit when tested for cord connection shall be connected to a supply circuit corresponding to the rating of the attachment plug.

42.4 The supply specified in 42.2 shall be protected by a branch-circuit protective device with a rating equal to 125 percent of the ampere rating of the unit or, when 125 percent of the ampere rating of the unit exceeds a standard branch circuit protector ampere rating, the next higher-sized device is to be used. Standard branch circuit protector ratings are indicated in Table 15.2. The supply specified in 42.3 shall be protected by a branch-circuit protective device sized to correspond to the ampere rating of the attachment plug.

42.5 The tests for an assembly will require connection to a test tank by means of nonmetallic pipe no more than 5 feet (1.72 m) long and no smaller in diameter than the inlet and outlet pipe fittings of the assembly. The test tank shall hold from 200 to 300 gallons (757 to 1136 L) and the water shall be at least 20 inches (508 mm) deep. Inlet and outlet pipes shall be separated at the tub at least 2 feet (610 mm) laterally. In addition, an assembly construction that is to be subjected to the Leakage Current Test in Water, Section 55, shall be tested as described in 55.4.

43 Leakage Current Test

43.1 A cord-connected unit and a convertible unit shall be subjected to a leakage current test in accordance with 43.2. The results are in compliance when the leakage current does not exceed 0.5 milliampere.

43.2 The leakage current is to be measured through a 500 ohm noninductive 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 insulated from ground. The supply voltage is to be in accordance with Table 42.1. The measurement is to be made with the unit operating, and again not operating.

43.3 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.

43.4 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 11.1. 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.

43.5 The measurement circuit for leakage current is to be as shown in Figure 43.1. 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 need not have all the attributes of the defined instrument.

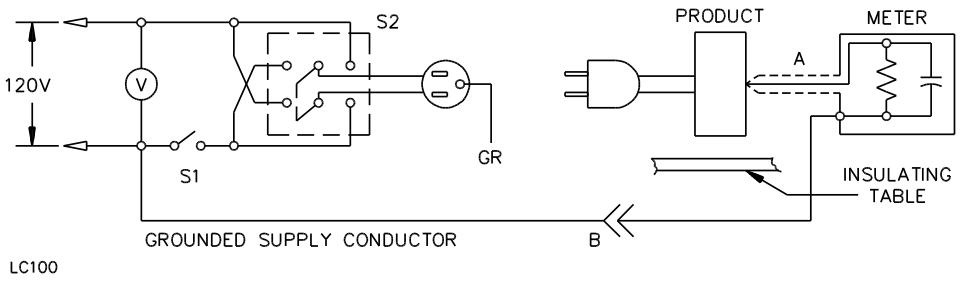
a) The meter is to have an input impedance as indicated in 43.2.

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.

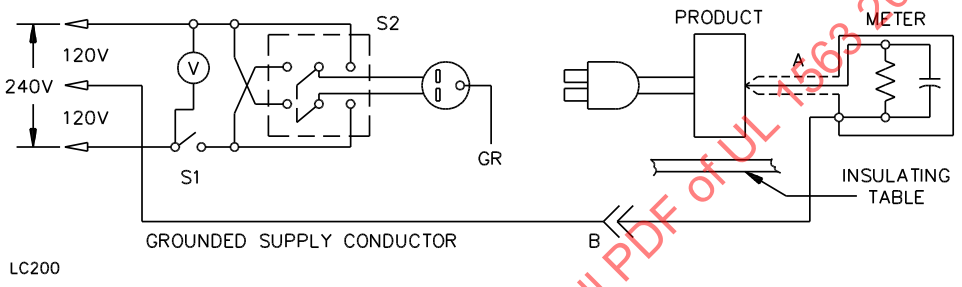
c) Over a frequency range of 0 – 100 kilohertz, the measurement circuitry is to have a frequency response (ratio of indicated to actual value of current) equal to the ratio of the impedance of a 500 ohm resistor shunted by a 0.45 microfarad capacitor to 500 ohms. At an indication of 0.5 milliampere or 3.5 milliamperes, the measurement is to have an error of not more than 5 percent at 60 hertz.

Figure 43.1

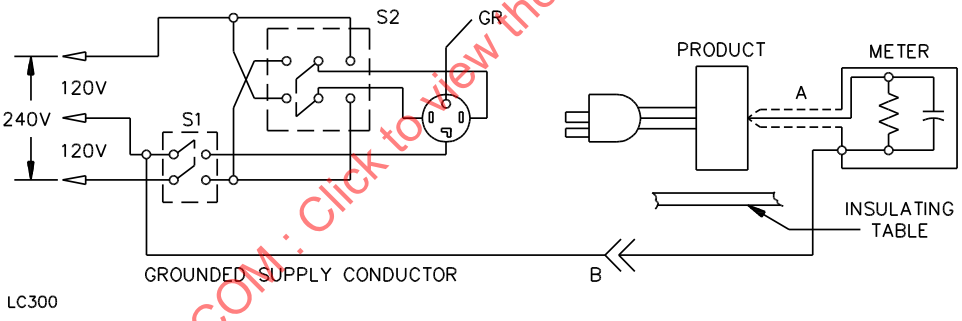
Leakage-current measurement circuits



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



Product intended for connection to a 3-wire, grounded-neutral power supply



Product intended for connection to a 3-wire, grounded-neutral power supply.

A – Probe with a shielded lead.

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

43.6 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 43.1, 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.

43.7 In most cases, the complete leakage current test program described in 43.6 shall 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.

44 Available Current Test

44.1 The available current (isolated or ground-referenced) from a live part or circuit that is accessible to the occupant or in contact with water shall not exceed the limits for a risk of electric shock as specified in 5.22 during any mode of operation when measured as described in 44.2 – 44.5.

44.2 The instrument used for this test shall be a milliampmeter having an internal impedance of 500 ohms. As an alternative, a 500-ohm noninductive resistance may be connected between the test points, and the available current calculated by dividing the voltage drop measured across the resistance by 500 ohms.

44.3 The available current is to be measured between:

a) Any two live parts accessible to the occupant of the spa;

b) Any live part accessible to the occupant of the spa and the supply equipment grounding conductor;

c) Any live part accessible to the occupant of the spa and the water;

d) (When the live parts are in contact with water) the water and the supply grounding conductor; and

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

44.4 With regard to the requirements in 44.2, any enclosure, barrier, or insulation used to isolate the live part or circuit from the occupant is to be disregarded and removed unless the enclosure, barrier, or insulation complies with 12.6.

44.5 The measurements are to be made with the spa insulated from ground. Water in the spa is to have a resistivity of 300 ohm-centimeters. Current available from the water is to be measured to a copper electrode plate having dimensions approximately twice the internal diameter of the largest pipe through

which the water circulates in the spa. The electrode is to be placed 1 inch (25.4 mm) from the inside wall of the spa shell directly over each water discharge and water pick-up port, one at a time.

44.6 The test is to be conducted with the controls adjusted to the most adverse condition.

45 Insulation Resistance Test

45.1 A permanently connected hot tub or spa and an assembly shall have an insulation resistance between live parts and noncurrent-carrying metal parts of not less than 250,000 ohms as determined by the use of a megohmmeter providing a test potential of 500 volts DC.

46 Starting Current Test

46.1 A unit shall operate as intended when connected to a supply protected by a Class H or equivalent fuse having an ampere rating in accordance with 42.4. The fuse shall not open and an overload protector (when provided as part of the unit) shall not trip.

Exception: A time-delay fuse may be used when the unit operates normally when protected by a time-delay fuse and is marked in accordance with 70.5.

46.2 In a test to determine whether a unit complies with the requirement in 46.1, the unit is to be started three times, with the unit at ambient temperature 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 operating cycle in the case of an automatic unit) and the motor is to be allowed to come to rest between successive starts.

47 Power Input Test

47.1 The current input to a unit shall not be more than 110 percent of the rated value in any mode of operation of the unit, with any controls adjusted for maximum current input when the unit is connected to a supply circuit as specified in 39.1.

48 Leakage Current Test or Insulation Resistance Test Following Humidity Conditioning

48.1 A unit shall comply with the requirements for leakage current in 43.1 or insulation resistance in 45.1, following exposure for 48 hours to air having a relative humidity of 88 ±2 percent at a temperature of 32 ±2°C (90 ±4°F).

48.2 To determine whether a hot tub or spa complies with the requirements in 48.1, a sample is to be heated to a temperature just above 34° C (93° F) to reduce the risk of condensation of moisture during conditioning. The heated sample is to be placed in the humidity chamber and conditioned for 48 hours under the conditions specified in 48.1. Following the conditioning, the sample is to be tested unenergized as described in 43.6(a), or in 45.1, as appropriate. The sample is then to be energized and tested as described in 43.6(b) or 43.6(c), or in 45.1, as appropriate. The test is to be discontinued when the leakage current stabilizes or decreases.

48.3 A subassembly containing only electrical parts of a hot tub or spa may be used for this test.

49 Dielectric Voltage-Withstand Test

49.1 While at the maximum operating temperature reached during intended use, each unit shall be subjected to the application of a 60 hertz potential as specified in Table 49.1. The test transformer shall have a capacity that is 500 volt-amperes or larger and an output voltage that is essentially sinusoidal. The

applied potential is to be increased gradually from zero to the required test value, and then is to be held at that value for 1 minute. The result is in compliance when there is no dielectric breakdown.

Table 49.1
Dielectric voltage-withstand test

Applied between	Potential (volts)
Live parts and grounded metal	1000
Transformer primary and secondary	2500
Accessible dead metal and live parts, grounded metal, and transformer secondary	1000[a]
Tub/skirt material used in lieu of spacings as specified in 12.4 and 12.5	1000[b]

[a] For a Class 2 secondary transformer operating at 30 V (42.4 V Peak) or less, the test potential is 500 V.

[b] Applied across actual thickness of material being used.

50 Temperature Test

50.1 A unit shall be subjected to the temperature test described in 50.2 – 50.10 under the conditions of maximum intended load as described in 42.1 – 42.4 and 47.1. The temperature at any point shall not be sufficiently high to constitute a risk of fire or to damage any material used in the unit, and the maximum temperature at specific points shall be no higher than the temperatures specified in Table 50.1.

Table 50.1
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

Table 50.1 Continued on Next Page

Table 50.1 Continued

Materials and components	°C	(°F)
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]		
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		
Class G, J, L, T, and CC:		
Tube	125	257
Ferrule or blade	110	230
Others[d]	90	194
3. Relay, solenoid, and coils (except motors and transformers) with		
a. Class 105 insulation system:		
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

Table 50.1 Continued on Next Page

Table 50.1 Continued

Materials and components	°C	(°F)
d. Class 155(F) insulation systems:		
Thermocouple method	130	266
Resistance method	140	284
4. Sealing compound[e]	See footnote e	
5. Transformers		
a. Class 105 insulation system:		
Thermocouple method	90	194
Resistance method	100	212
b. Class 120(E) insulation system:		
Thermocouple method	100	212
Resistance method	120	248
c. Class 130 insulation system:		
Thermocouple method	110	230
Resistance method	120	248
d. Class 155(F) insulation system:		
Thermocouple method	130	266
Resistance method	140	284
C. CONDUCTORS		
1. Rubber- or thermoplastic-insulated wires and cords[d]	60	140
2. Copper conductors		
a. Tinned or bare strands having:		
i. A diameter less than 0.015 inch (0.38 mm)	150	302
ii. A diameter of 0.015 inch or more	200	392
b. Plated with nickel, gold, silver, or a combination of these	250	482
3. Termination of copper conductor in a pressure terminal connector unless both are tinned, nickel coated, or silver plated	150	302
D. ELECTRICAL INSULATION – GENERAL		
1. Fiber used as electrical insulation	90	194
2. Phenolic composition used as electrical insulation or as a part the deterioration of which could result in a risk of fire or electric shock		
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[f]	50	122
b. Nonmetallic[f]	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[f]	60	140
b. Nonmetallic[f]	85	185
3. Surfaces other than a heating function surface and known to be hot due to proximity to a heating function surface		

Table 50.1 Continued on Next Page

Table 50.1 Continued

Materials and components	°C	(°F)
a. Metallic[f]	70	158
b. Nonmetallic[f]	95	203
F. OTHER		
1. Wood and other combustible material	90	194
2. At any part within a terminal box or wiring compartment of a permanently connected unit[g]	60	140
3. A surface upon which a stationary unit may be mounted in service, and surfaces that may be adjacent to the unit when so mounted	90	194

[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 maximum temperature specified in this table if the temperature, as measured by the resistance method, is not more than that specified. The temperature measured by means of a thermocouple may be more than the specified value by:

1. 5°C (9°F) for Class 105 insulation systems on coil winding of alternating-current motors, open type; and

2. 10°C (18°F) for Class 130 or Class 155 insulation systems on coil windings of alternating-current motors, open type.

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

[c] A capacitor that operates at a temperature of more than 90°C (194°F) may be investigated on the basis of its marked temperature limit.

[d] A component that has been investigated and determined to function without risk of fire at a higher temperature may be used at that temperature.

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

[f] For a surface 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, the nonmetallic surface maximum temperature limits are to be applied.

[g] See 15.2.6.

50.2 A component of a unit that has been tested individually to determine compliance with temperature requirements need not be tested again unless it is further enclosed in the application or is subjected to external sources of heat in the application. Such components, although further enclosed in a hot tub or spa, may be subjected to a limited investigation to determine the effect of the enclosure on those temperatures which are critically close to the limiting temperatures.

50.3 Coil or winding temperatures are to be measured by thermocouples unless the coil is inaccessible for mounting of these devices (for example, a coil encapsulated in sealing compound) or unless the coil wrap includes thermal insulation or more than two layers, 1/32 inch (2.4 mm) maximum, of cotton, paper, rayon, or the like, in which case the change-of-resistance method may be used. For a thermocouple measured temperature of a coil of an alternating-current motor (other than a universal motor) having a diameter of 7 inches (178 mm) or less (items 8 and 20 in Table 50.1), the thermocouple is to be mounted on the integrally applied insulation on the conductor.

50.4 The temperatures specified in Table 50.1 are based on an assumed ambient temperature of 25°C (77°F). However, the test may be conducted within the range of 20 – 30°C (68 – 86°F) if the temperature is corrected to 25°C. When a corrected temperature exceeds the value specified in Table 50.1, the test may be repeated at an ambient temperature closer to 25°C at the request of the manufacturer.

50.5 When the unit incorporates a reel for the power supply cord, one-third of the length of the cord is to be unreeled for the temperature test.

50.6 Temperatures, other than as noted in 50.3, 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 employ 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 when they are immersed in water during testing.

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

50.8 Unless the unit is obviously not intended for continuous operation, this test will be continued until constant temperatures are attained. Thermal equilibrium is considered to exist when three successive readings taken at intervals of 10 percent of the previously elapsed duration of the test, but not less than 5 minute intervals, indicate no change.

50.9 The water temperature in a hot tub or spa (or in a test tank for an assembly) at the start of the temperature test shall be ambient room temperature.

50.10 The regulating control shall be set at maximum, and the unit is to be operated until constant temperatures are attained. Any blower shall not be operating and any air induction control shall be closed during the test to determine maximum water temperatures, but shall be operating during the normal temperature test. A blower that heats the water, if provided, shall be operating during the entire test.

51 Water Temperature Test

51.1 To determine compliance with 35.1, the unit is to be operated as described in the Temperature Test, Section 50.Results are in compliance when:

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

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

c) The temperature-limiting control does not operate.

51.2 An assembly is to be tested under the most severe conditions of use based on the manufacturer's installation instructions. Factors to be considered include length of pipe between assembly and tub, size of pipe, and size and type of tub. This may necessitate that more than one test construction be provided.

51.3 Testing shall take into consideration any effects on flow due to filter loading.

51.4 The maximum water temperatures specified in 51.1(a) assume the temperature-regulating control is operating at the highest temperature allowed by its operating tolerance.

52 Abnormal Water Temperature Tests

52.1 Temperature-limiting control test

52.1.1 To determine compliance with the temperature requirement in 36.1, the unit is to be operated as described in the Temperature Test, Section 50, beginning at the maximum water temperature recorded in the water temperature test described in 51.1 and with the regulating control shunted so that the limit control will be the only device in the circuit that will limit the temperature of the water. The results are in compliance when the temperature of the water at any inlet to the tub does not exceed 50°C (122°F).

52.2 Kinetic heating test

52.2.1 While at the maximum water temperature from the water temperature test described in 51.1, a unit covered as specified in 52.2.2, shall be operated circulating water at the maximum flow rate without the heater operating until thermal equilibrium as defined in 50.8 is attained or until ultimate results occur. Any blower shall not be operating and any air induction control shall be closed. A blower that heats the water (when provided) shall be operated. The results are in compliance when the water at any tub inlet does not exceed 50°C (122°F).

Exception: This test is not required to be conducted when the unit is provided with high-limit circuitry for de-energizing the heater in the event the water temperature exceeds 50° C and when, in addition to shutting off power to the heater, the high-limit circuitry also shuts off power to all pumps.

52.2.2 The cover used in the test described in 52.2.1 shall be 3-inch (76.2-mm) thick foamed polystyrene applied to cover completely the top surface of the spa or test tank, as applicable.

52.2.3 For the purpose of conducting the test specified in 52.2.2 and 52.2.3, all time-out features not considered to be reliable are to be bypassed.

53 Motor Protector Test

53.1 General

53.1.1 Ordinarily, a motor provided with inherent over-temperature protection complying with the requirements in the Standard for Overheating Protection for Motors, UL 2111; the Standard for Thermally Protected Motors, UL 1004-3; or the Standard for Electronically Protected Motors, UL 1004-7 and impedance-protected motors complying with UL 2111, or the Standard for Impedance Protected Motors, UL 1004-2; are considered to comply with requirements in 53.1.1 – 53.5.2 without the necessity of further tests unless the impedance protected motor is subjected in the appliance to some condition, such as restricted ventilation, proximity to an external source of heat, and the like.

53.2 Temperature

53.2.1 When the motor is operating with the maximum load it can carry without causing the protective device to operate, the temperature on a Class 105 insulated motor winding shall not exceed 140° C (284°F); the temperature on a Class 130 insulated motor winding shall not exceed 165°C (329°F); and the temperature on a Class 155 insulated winding shall not exceed 190°C (374°F)

Exception: This requirement does not apply to a motor moving air only by means of a fan or blower directly attached to the motor shaft.

53.3 Locked rotor protection

53.3.1 When the rotor of a motor is locked, the temperature on the windings of the motor shall not exceed the value specified in Table 53.1. The average temperature is to be determined by taking the arithmetic means of both the minimum and maximum temperatures.

Table 53.1
Maximum temperatures during locked-rotor test

	Maximum						Average					
	Class 105 insulation,		Class 130 insulation,		Class 155 insulation,		Class 105 insulation,		Class 130 insulation,		Class 155 insulation,	
	°C	(°F)	°C	(°F)	°C	(°F)	°C	(°F)	°C	(°F)	°C	(°F)
During first hour of operation	200	392	225	437	250	482	–	–	–	–	–	–
After first hour of operation	175	347	200	392	225	437	150	302	175	347	200	392

53.3.2 Temperatures are to be measured by thermocouples on the surface of coils of the motor. During the test, the motor is to be connected to a supply circuit of the voltage specified in 42.1. The test on a motor having a manually reset device is to be continued for four operations of the protective device, with the device being reset as quickly as possible after it has opened. For a motor having an automatically reset device, the locked rotor test is to be continued for 72 hours unless the appliance includes other controls, such as a timer, that will positively and reliably limit the duration of the operation to a shorter interval.

53.4 Endurance

53.4.1 When a motor having an automatically reset thermal protector is tested as described in 53.4.2, there shall be no permanent damage to the motor including excessive deterioration of the insulation, and if the device permanently opens the circuit, it shall do so without grounding to the motor frame, damage to the motor, or introduction of a risk of fire.

53.4.2 For the test specified in 53.4.1, the rotor of the motor is to be locked and the motor is to be connected to a supply circuit having a voltage of 100 – 110 percent of the rated voltage of the motor. The results are in compliance when the protector of the motor performs successfully for 15 days.

Exception: The test is to be terminated when the appliance includes other controls, such as a timer, that will limit the operation to a shorter interval or when the device permanently opens the circuit prior to the 15 day expiration.

53.4.3 A manually-reset thermal protector of a motor shall interrupt, for 50 operations without damage to itself, the locked rotor current of the motor for which it is intended when operated with the motor connected to a supply circuit having a voltage of 100 – 110 percent of the rated voltage of the motor. The protector is to be re-closed as quickly as possible after opening the circuit. The results are in compliance when there is no permanent damage to the motor.

53.5 Limited short circuit

53.5.1 There shall be no ignition of cotton surrounding the enclosure of a thermal protector of a motor when subject to limited short-circuit currents as described in 53.5.2.

53.5.2 Three samples of the device are to be subjected to limited short-circuit currents. For a motor rated 1/2 horsepower (373 W) or less and 250 volts or less, the current is to be 200 amperes. For a motor having other ratings, but not more than 1 horsepower (746 W), the current is to be 1000 amperes. The power factor of the test circuit is to be 0.9 – 1.0, and the circuit capacity is to be measured without the device in the circuit. A Class K5 nonrenewable cartridge fuse is to be connected in series with the device under test. The fuse rating is to be no less than four times the rated current of the appliance but no less than 20 amperes for a unit rated 150 volts or less and no less than 15 amperes for a unit rated more than 150 volts. The test on one sample is to be conducted by closing the device on the short circuit.

54 Water Exposure Test

54.1 General

54.1.1 A unit shall be subjected to splashing, seal damage, reverse siphoning, and simulation of rain. The results are in compliance when, after each test, the unit complies with the Dielectric Voltage-Withstand Test, Section 49, and the Leakage Current Test, Section 43, or, if appropriate, the Insulation Resistance Test, Section 45.

Exception: A unit marked for indoor-use only is not required to be subjected to the water exposure test.

54.1.2 A separate sample may be used for any water exposure test.

54.1.3 In the tests specified in 54.2.1 – 54.3.2, the water is to have a resistivity of 300 ohm-centimeters. In the tests specified in 54.4.1, the water is to have a resistivity of 2540 ohm-centimeters.

54.2 Splashing

54.2.1 A hot tub or spa shall be subjected to the pouring of 20 gallons (75.7 L) of water over any portion of the periphery of an enclosure containing openings or cover seals or cord, conduit, and control shaft entrance points. The test shall be conducted to simulate the splashing of water over the edges of the hot tub or spa by locating an open top container holding 20 gallons of water such that the edge is 1 inch (25.4 mm) outside of the inner walls of the tub and tipped to permit the water to pour over the outer walls of the enclosure, conforming as closely as possible to the enclosure surface. When an enclosure is not provided over all of the components, as for a hot tub or spa intended for recessing in the ground or in the floor, the test shall be conducted on a unit constructed in the manner in which it leaves the factory.

54.2.2 The test is to be conducted with the unit operating, and repeated with the unit not operating.

54.3 Seal test

54.3.1 A pump not previously so investigated shall be tested to determine the effect of operation with a shaft seal in a severely deteriorated condition. One of the following two methods is to be used:

a) The pump is to be operated dry for 7 hours after which it is to be operated for 1 hour under intended operating conditions.

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 for 7 hours.

54.3.2 After being subjected to one of the two tests in 54.3.1, the unit is to stand for 1 hour to permit water leakage and then is to be tested as described in 54.1.1.

54.4 Simulated rain

54.4.1 A unit shall be subjected to simulated rain as described in 54.4.3 – 54.4.5.

Exception No. 1: A unit marked for indoor-use only is not required to be subjected to the simulated rain.

Exception No. 2: A hot tub or spa with no openings in the outer enclosure and no electrical components mounted on the inside walls of the outer enclosure is not required to be subjected to the simulated rain.

54.4.2 The unit is to be oriented so as to promote the wetting of insulation and live parts. All motors shall be operating during the test.

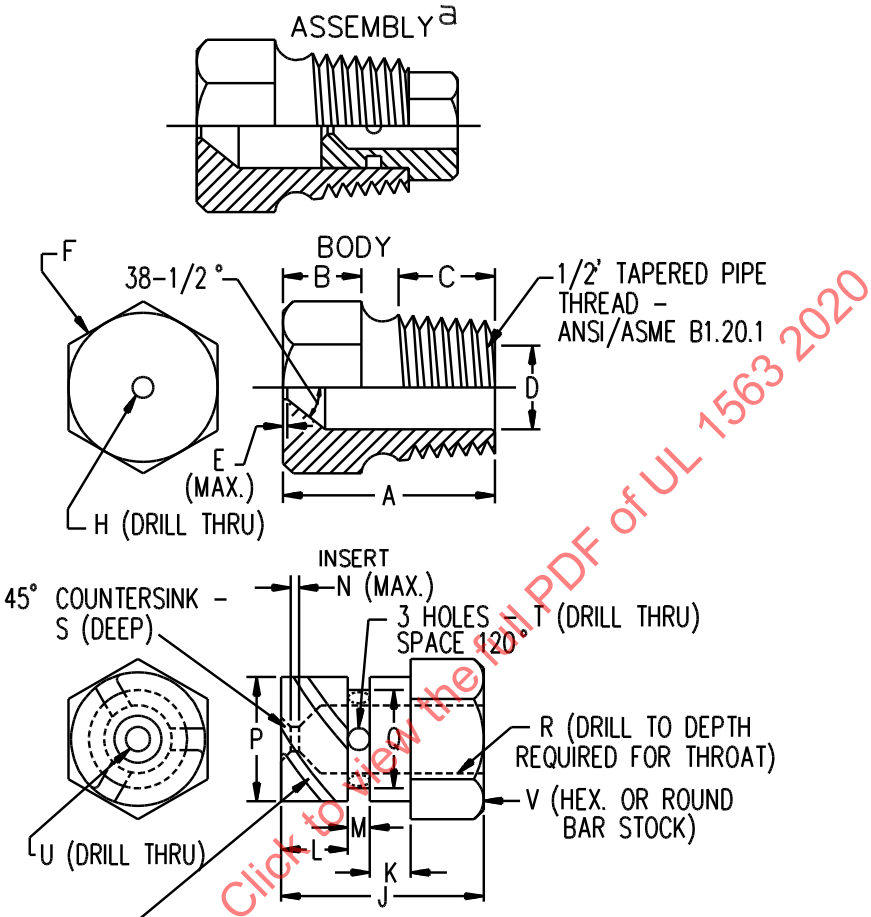
54.4.3 The unit is to be subjected to 4 hours of a water spray adjusted to be approximately the equivalent of a beating rain. The water to be used for the test shall have its resistivity adjusted (before the test is started) to comply with 54.1.3. At the conclusion of the test, the resistivity of the water shall be within ±10 percent of the original value at 25°C (77°F).

54.4.4 The spray is to be applied to the unit at an angle of 45 degrees to the vertical with all nozzle pressures maintained at 5 pounds per square inch (34.5 kPa).

54.4.5 The equipment shall be as shown in Figure 54.1 and Figure 54.2.

Figure 54.1

Simulated rain test spray head



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

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

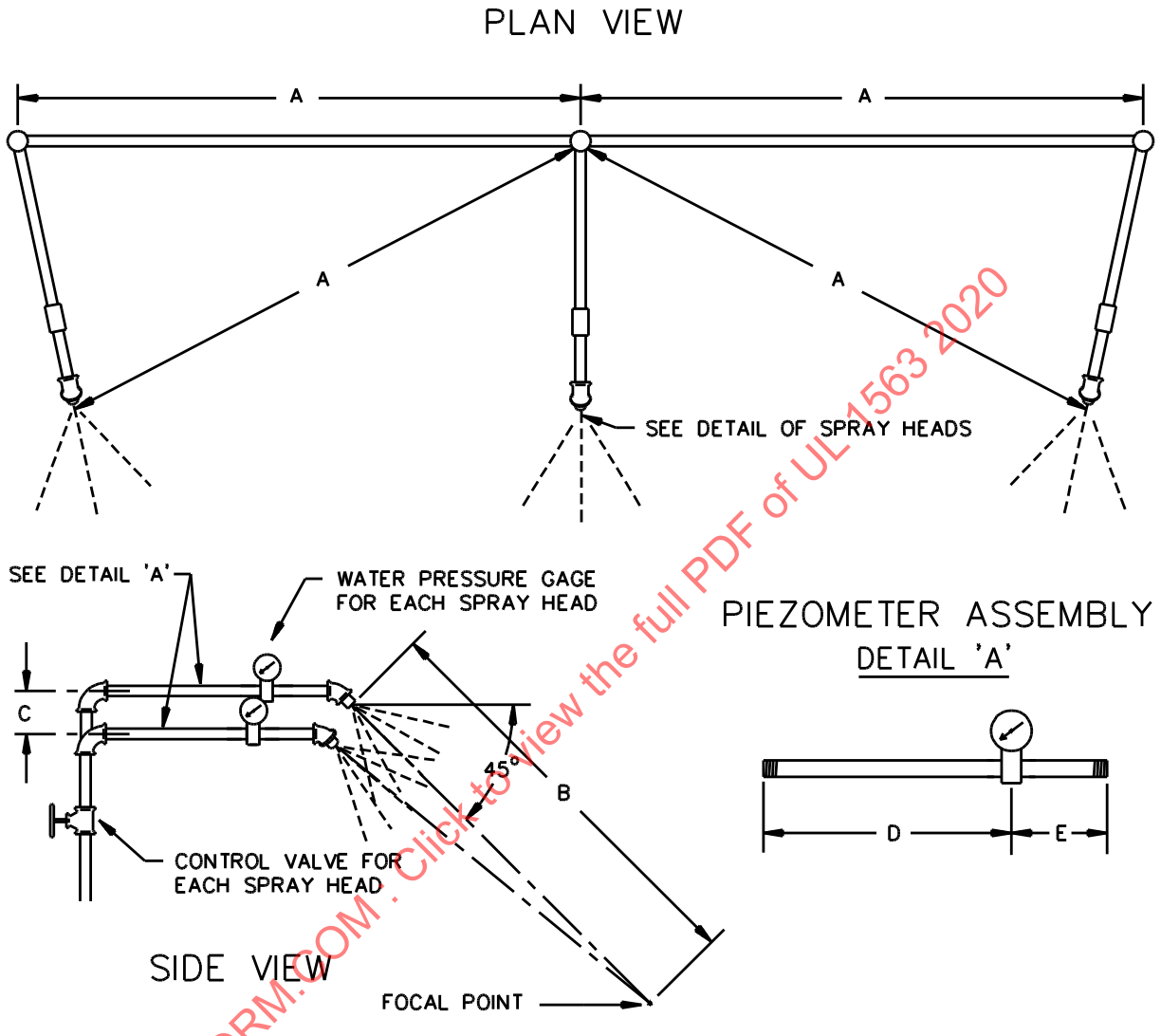
[b] ANSI B94.11M Drill Size

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

RT100E

Figure 54.2

Simulated rain test spray head piping



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

RT101E

55 Leakage Current Test in Water

55.1 A unit provided with an electric water heater and not equipped with leakage current collectors of a type described in 18.2 shall be subjected to a condition of heater breakdown as described in 55.2. The results are in compliance when the leakage current does not exceed 0.5 milliampere when tested in accordance with 55.2 – 55.6.

55.2 For this test, the unit is to be supplied through an isolating transformer having the capacity to provide rated voltage during the test. The test circuit is to be as shown in Figure 55.1 – Figure 55.3. The impedance of the milliampmeter is not to exceed 500 ohms. As indicated in Figure 55.3, the ungrounded line terminal (or both, if there are two) for the equipment is to be connected to one transformer lead while the other transformer lead is to be connected to:

a) The enclosure ground terminal,

b) The neutral terminal, and

c) One side of the measuring circuit.

Figure 55.1

Hot tub electrode location

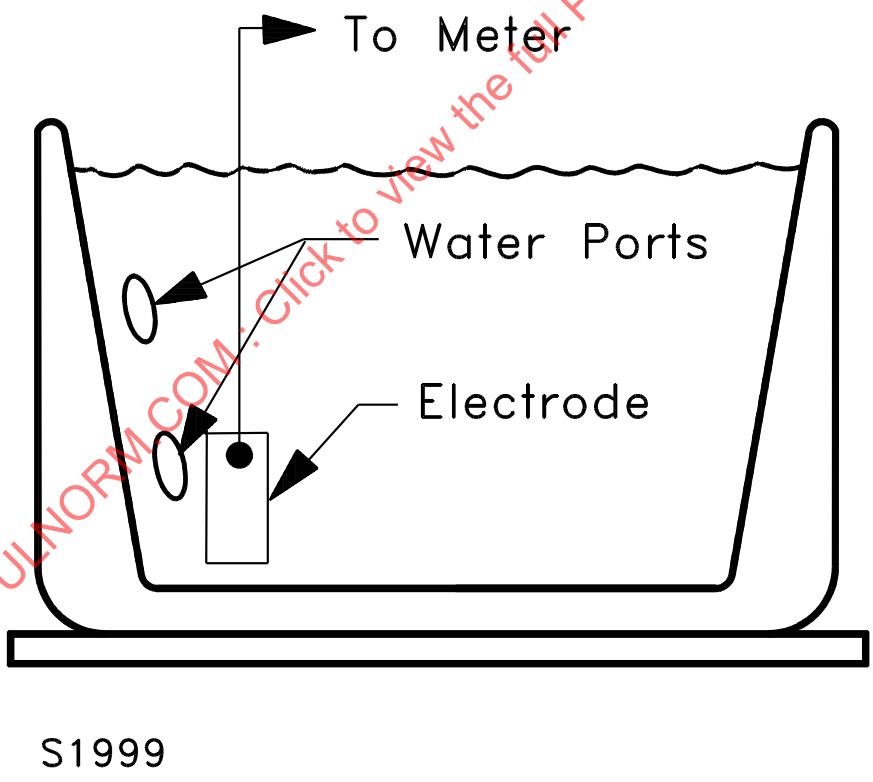
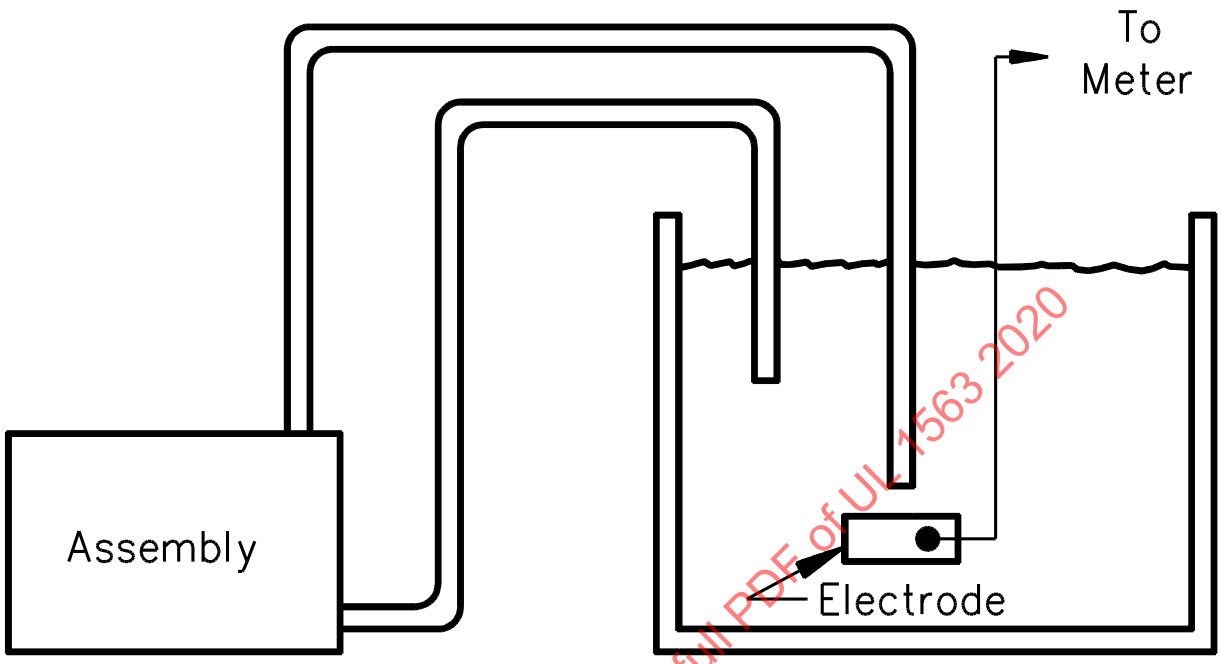


Figure 55.2

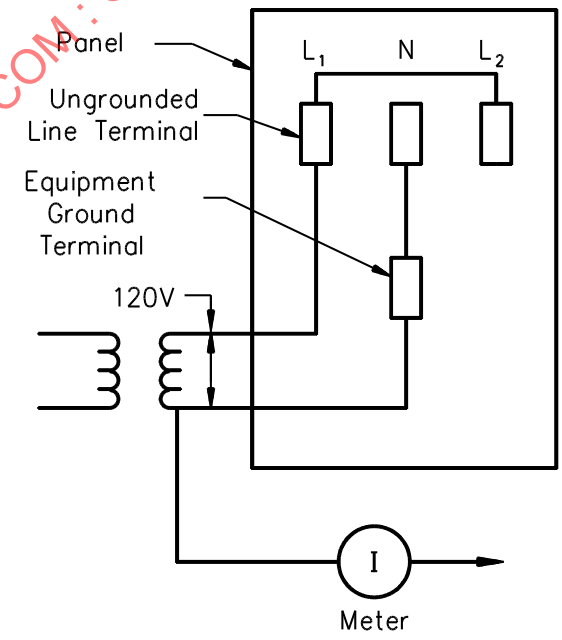
Assembly electrode location



S2000

Figure 55.3

Connections in panel



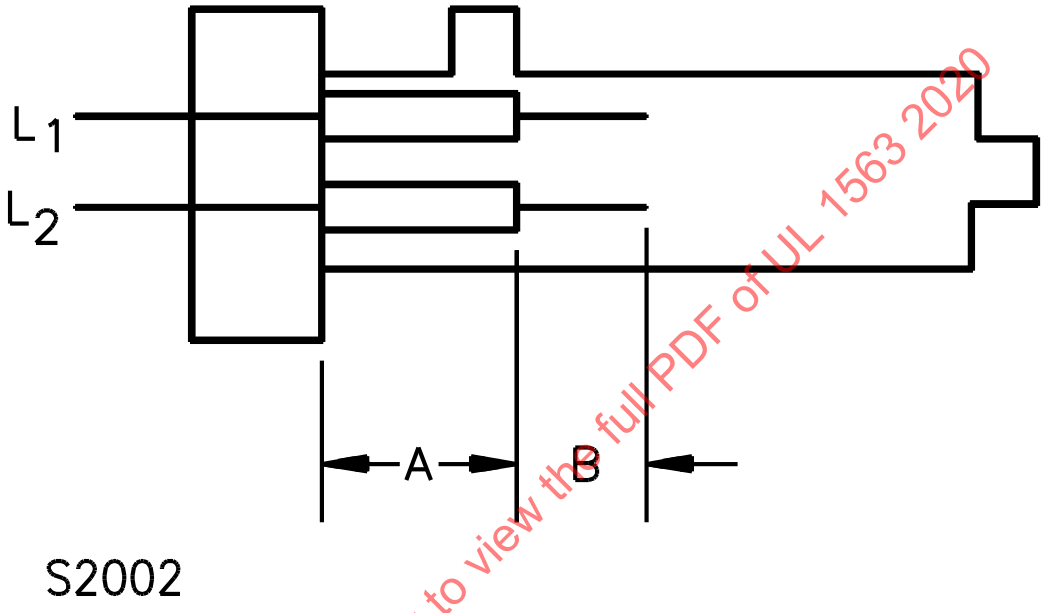
S2001

240-volt panel shown. For a 120-volt panel, eliminate L_2 and connect N to L_2 element terminal.

55.3 The heating element is to be altered to meet the description given in Figure 55.4 so that approximately 1 inch (25.4 mm) of the heating element conductor connected to each heater terminal is exposed to contact with the water in the circulating system. The water is to have a resistivity of 300 ohm-centimeters.

Figure 55.4

Altered element



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

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

55.4 Measurements made in a hot tub or spa are to be made with the unit insulated from ground. The test tank used with an assembly is to be of insulating material with any metal hardware insulated from ground. The connection of noncurrent-carrying metal to the equipment grounding terminal is not to be disturbed, and any protective devices are to remain in the circuit.

55.5 Water pipe connections between an assembly and the test tank are to be nonmetallic, no more than 5 feet (1.72 m) long, and of the same diameter as the water connections to the assembly.

55.6 The current flow is to be measured to a copper electrode plate having dimensions approximately twice the internal diameter of the pipes through which the water circulates in the tub. The electrode is to be placed 1 inch (25.4 mm) from the inside walls of the tub directly over each water discharge and water pick-up port, one at a time, or 1 inch from the underwater point nearest to grounded metal that the occupant of the tub can reach while the electrical components are energized. This setup is indicated in Figure 55.1 and Figure 55.2.

55.7 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 tub;

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.

56 Test for Resistance to Impact

56.1 A spa shall withstand the impact described in 56.2 without:

a) Reducing spacings below the minimum values shown in Spacings, Section 25;

b) Making accessible to contact live parts and, for cord and plug connected units, dead metal parts that are separated from live parts by insulation only;

c) Breaking, cracking, or rupturing to produce an adverse effect on the insulation; and

d) Producing any other condition that would increase the risk of electric shock.

Exception: A spa complying with the minimum thicknesses specified in 8.3.2 and 8.3.4 is not required to be subjected to this test.

56.2 The unit is to be subjected to an impact of 5 foot pounds (6.8 J) on any surface that is exposed to a blow during use. The impact is to be produced by dropping a steel sphere, 2 inches (50.8 mm) in diameter and weighing 1.18 pounds (0.54 kg), from the height necessary to produce the specified impact. Where the impact cannot be produced on the desired surface by means of a vertical drop, the sphere can be swung as a pendulum to produce the impact.

56.3 For products intended for indoor use only, the impact specified in 56.2 shall be conducted in an ambient temperature of 0 ±2°C (32 ±3.6°F). For products intended for outdoor use, the impact shall be conducted after the specimen has been in an ambient temperature of minus 35.0 ±2°C (minus 31.0 ±3.6°F) for at least 3 hours.

56.4 In a determination of whether a handle, knob, or actuator complies with the requirements in 32.10 or 32.11, two samples are to be tested. These tests are to be conducted in addition to those required in 56.1 and 56.2 and before the splashing, rain, dielectric voltage-withstand, and leakage current tests. The switch becoming inoperative is not an unacceptable result.

56.5 A separate temperature indicating device provided in accordance with 35.4.1 shall continue to function properly after being dropped three times from a height of 3 feet (0.9 m) onto a concrete surface. Testing shall be conducted with the test samples at the temperatures specified in 58.2.1. One drop shall impact the temperature sensor of an electronic device. Proper function shall be determined with the unit immersed in the intended manner.

57 Ozone Offgas Test

57.1 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 approximately 1000 cubic feet (approximately 8 by 10 by 12 feet) with all interior surfaces covered with a material that does not react with ozone. The door to the test room is to be sealed during the test.

57.2 The spa to be tested is to be located in the approximate center 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.

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

57.4 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.

57.5 Ozone measurements are to be taken 5 minutes before the test and then continuously until 5 minutes after the test. During the test, the spa 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.

57.6 Ozone measurements made during the test specified in 57.5 shall not exceed the limits specified in 37.8.2 and 37.8.3.

57.7 Ozone measurements made during the 5 minutes after the test shall not exceed the transitory offgas limits specified in 37.8.3.

58 Abnormal Operation Tests

58.1 Low water and no water test

58.1.1 While at maximum operating temperature and without the temperature-regulating control, each unit shall be operated for 7 hours; until the dry fire protection device or circuit, if provided, opens the heater circuit; or until ultimate results occur; with the water level in the tub:

a) Below the level of the skimmer;

b) Below the heater enclosure;

c) Below the suction fitting(s); and

d) Empty.

58.1.2 The results of the procedure in 58.1 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 or damage to thermal insulation or electrical insulation;

c) The temperature of the water at the outlet of the heater enclosure does not exceed 70° C (158°F); and

d) The temperature of the water entering the tub does not exceed 50°C (122°F) for longer than 15 minutes.

58.1.3 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 shall be subjected to 50 cycles of operation without water. Each cycle shall begin at room temperature or other temperature, when agreeable to 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 35.5.1. When one of the three thermostats is not within the specified tolerance, the test may be repeated with three new thermostat samples. The results are in compliance when all three additional thermostats are within the tolerance after the test.

58.2 Interrupted power

58.2.1 In accordance with 37.3.1, a unit using 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 this reaches a maximum value, the power shall be restored. The results are in compliance when at any time the temperature of the water at the center of the water outlet to the tub does not exceed 50°C (122°F) and there is no damage to the heater enclosure. For this test, all temperature controls shall be in operation.

58.3 Water flow interruption

58.3.1 When either a pump motor protective device or a pump motor circuit breaker or fuse can operate without disconnecting power from the heater, the test in 58.2.1 shall be repeated with interruption of power to the pump motor alone.

58.4 Water back flow

58.4.1 As required in 37.5.1, interrupting power to a blower or to a water-sanitizing device shall not result in water contacting live parts or electrical insulation. The test is to be conducted by interrupting power to the blower or to the water-sanitizing device, or both, first with the water-circulating pumps operating and then simultaneously interrupting power to all components. When water is prevented from flowing in the air lines by routing the air lines to a point above the water level, a determination shall be made that displacement of water in the tub will not result in water passing the high point in the tubing. The test is to be conducted with and without the blower or water-sanitizing device, or both, operating.

58.4.2 When a blower or water-sanitizing device introduces air directly into the water-circulating pipes of a spa or assembly, the unit is to be operated to cause maximum water flow. Water flow is to be obstructed at all outlets simultaneously for 1 minute. The results are in compliance when water does not contact live parts or electrical insulation. This test is to be conducted with and without the blower or water-sanitizing device, or both, operating.

58.5 Reverse hydrostatic pressure

58.5.1 To comply with 37.5.3 and 37.5.4, three samples of the check valves shall be subjected to a reverse hydrostatic pressure test. The results are in compliance when, for the range of water pressures given in 37.5.3 and 37.5.4, the valves do not leak sufficient water in one hour to wet paper located beneath the valve assembly when the valve is oriented with the seal directed vertically downward.

58.6 Electrolytic capacitor test

58.6.1 For the individual enclosure of an electrolytic capacitor not provided with means for venting but provided with an opening more than 1/16 inch (1.6 mm) wide between the capacitor and the enclosure (in accordance with Exception No. 2 to 33.1), three samples of the capacitor, mounted in the usual manner and with cotton placed around openings in the enclosure are to be subjected in turn to such over-voltage as to cause malfunction of the capacitor. The results are in compliance when the cotton does not ignite during the test.

58.7 Transformer test

58.7.1 Three transformers are to be placed on a tissue-paper covered soft wood surface and each covered with a layer of cheesecloth. A one-ampere cartridge fuse is to be connected in series from the core and the shield, if applicable, of each transformer to ground. Each transformer is to be protected by an overcurrent device. The device is to be the same as provided in the unit to protect the transformer, or if none is provided, is to be a branch circuit type as specified in 42.4. With all secondaries short-circuited, each transformer is to be energized as specified in 42.1 for 7 hours or until ultimate results occur. Results are in compliance when:

a) The ground fuse remains intact,

b) Each transformer withstands the potential specified in the Dielectric Voltage-Withstand Test, Section 49, while still warm from this test, and

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

Exception: The test may be conducted in a manner similar to that described in 58.7.1 but with the transformer(s) installed in the end product.

58.8 Electronic component test

58.8.1 Each electronic component in the circuits specified in 37.7.1 is to be open and short-circuited, one at a time, when operating under normal load conditions to determine that no risk of fire, electric shock, or injury to persons results. Each component is to be tested three times to ensure that the failure mode is consistent.

59 Flow Rate Test

59.1 The flow rate of a spa or an equipment assembly is to be measured while the product is operated at maximum water flow and as described in the Temperature Test, Section 50, using a flow meter with at least ±2 percent accuracy. During this test, a product with multiple pumps/controls is to be operated in whichever mode will maximize the water flow through the suction opening being tested. This could result in different pump/control settings for each suction opening tested. For an equipment assembly, the flow meter is to be attached to the suction side of the test tank with the assembly connected as specified in 42.5. For a spa, the flow meter is to be attached to the suction side of the water pump in the spa or, if possible, to each suction opening in turn, and, if agreeable to all concerned, the flow meter is to be installed underwater at the suction opening. The flow meter is to use the same size plumbing as used in the spa or the equipment assembly. The maximum flow rate shall be used to rate the product or, if applicable, each opening. Filters are to be removed or bypassed during this test if the unit can operate in this condition but only if doing so results in a worst-case condition.

60 Strain-Relief Test

60.1 When tested in accordance with 60.2, the strain-relief means provided on a flexible cord shall be subjected to a direct pulling force of 35 pounds (155.7 N) applied to the cord for 1 minute, with the conductor connections within the unit disconnected.

60.2 A 35-pound pulling force (155.7 N) is to be applied to the cord such that the strain relief means will be stressed from any angle that the construction of the unit permits. The results are not in compliance when, at the point of disconnection of the conductors, there is such movement of the cord as to indicate that stress would have resulted on the connections.

61 Metallic Coating Thickness Test

61.1 In accordance with 13.7, the thickness of a zinc or cadmium coating shall be determined by the metallic coating thickness test as follows:

a) The solution to be used for the test is to be made from distilled water and is to contain 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, ($H_2 SO_4$). The latter is equivalent to 27 milliliters per liter of concentrated sulfuric acid, specific gravity 1.84, containing 96 percent $H_2 SO_4$.

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 tapered to form a tip, the drops from which are about 0.05 milliliter each. To preserve an effectively constant level, 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. When 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 should be kept in the test room long enough to acquire the temperature of the room, which should be noted and recorded. The test is to be conducted at a room temperature between 21 and 32°C (70 and 90°F).

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

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

f) After cleaning, the sample to be tested is to be put in place under the orifice. 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 at that point.

g) Each sample of a test lot is to be subjected to the test at three or more points (excluding cut, stenciled, and threaded surfaces) on the inside surface and at an equal number of points on the outside surface, at places where the metallic coating may be 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) Calculation of the thickness of the coating being tested is made by selecting from Table 61.1 the thickness factor appropriate for the temperature at which the test was conducted and multiplying by the time in seconds required to expose base metal as noted in (f).

Table 61.1
Thickness factors

Temperature,		Thickness factors, 0.00001 inch (0.00025 mm)	
°F	(°C)	Cadmium platings	Zinc platings
70	21.1	1.331	0.980
71	21.7	1.340	0.990
72	22.2	1.352	1.000
73	22.8	1.362	1.010
74	23.3	1.372	1.015
75	23.9	1.383	1.025
76	24.4	1.395	1.033
77	25.0	1.405	1.042
78	25.6	1.416	1.050
79	26.1	1.427	1.060
80	26.7	1.438	1.070
81	27.2	1.450	1.080
82	27.8	1.460	1.085
83	28.3	1.470	1.095
84	28.9	1.480	1.100
85	29.4	1.490	1.110
86	30.0	1.501	1.120
87	30.6	1.513	1.130
88	31.1	1.524	1.141
89	31.7	1.534	1.150
90	32.2	1.546	1.160

62 Structural Integrity Tests

62.1 General

62.1.1 The unit is to be installed in accordance with the manufacturer's instructions. Features that may present the worst-case scenario shall be operating; this could result in testing multiple configurations and/or settings. Any features or accessories that are removable are to be removed when doing so results in a worst-case condition.

62.1.2 These tests are to be conducted with the unit filled with water, and then drained, unless one condition represents the other.

62.1.3 At the conclusion of each test, a visual inspection is to be conducted to determine if any signs of physical damage (such as discoloration of material, cracking, chipping, and loss of material) has occurred.

62.1.4 A unit shall withstand the tests described in 62.2.1, 62.3.1, and 62.3.2 without:

a) Reducing spacings below the minimum values shown in Spacings, Section 25;

b) Making accessible to contact live parts and, for cord- and plug-connected units, dead-metal parts that are separated from live parts by insulation only;

c) Breaking, cracking, or rupturing to produce an adverse effect on the insulation, ability to provide protection from rain, or other outdoor-use elements; and

d) Producing any other condition that would increase the risk of fire, electric shock, and/or injury to persons.

62.1.5 When necessary to determine whether a unit complies with the requirements as described in 62.2.1, 62.3.1, and 62.3.2, the Dielectric Voltage-Withstand Test, Section 49, or the Water Exposure Test, Section 54, are to be conducted.

62.1.6 Locations or components that are likely to be used as seats, steps, or the like during normal or abnormal use are to be subjected to the static loading test in 62.2.1.

62.1.7 Locations or components that are likely to be used as barriers (such as a spa skirt, door, cover, lid, screen, or similar parts) providing weather protection, or otherwise preventing or minimizing accessibility or the like during normal or abnormal use, are to be subjected to the impact load test in 62.3.1 and 62.3.2.

62.2 Static loading test

62.2.1 A sample of the unit is to be installed in accordance with the manufacturer's instructions. A load of 292 pounds (132 kg) is to be applied perpendicular to the surface being tested by means of a rigid disc measuring approximately 3 inches (76 mm) in diameter covered by approximately 1/2 inch (12.7 mm) thickness of sponge rubber or other suitable soft material between the disc and the surface being tested. For each test location, the load is to be applied for 2 minutes.

62.3 Impact load test

62.3.1 A 5-inch (125-mm) diameter sandbag with a mass of 11 pounds (5 kg) is to be suspended from an arm 47-1/4 inches (1.2 m) in length so that, at rest, it just touches the desired point of impact. The impact locations are selected based on areas, locations, or components having the least structural support, or the highest risk of being subjected to the mechanical abuse anticipated by this test.

62.3.2 The impact is to be conducted twice at each location by releasing the sandbag from the position on its arc of travel having an elevation of approximately 30 inches (76 cm) greater than its resting position as specified in 62.3.1.

MANUFACTURING AND PRODUCTION-LINE TESTS

63 Grounding Continuity Test

63.1 As a routine production-line test, each unit that has a power supply cord having a grounding conductor shall be tested for continuity between the grounding blade of the attachment plug and the inaccessible dead metal parts of the appliance that are required to be grounded. This may require testing before final assembly of the enclosure.

63.2 Any indicating device (an ohmmeter, a battery-and-buzzer combination, or the like) may be used to determine compliance with the grounding continuity requirement in 63.1.

64 Dielectric Voltage-Withstand Test

64.1 As a routine production-line test, each unit shall withstand without breakdown, the application of either:

a) One thousand V AC or 1400 V DC for one minute or

b) Twelve-hundred V AC or 1700 V DC for one second,

as specified in 64.3.

64.2 Factory dielectric voltage-withstand test equipment shall have the capacity as to maintain the test voltage across the insulation being tested. Breakdown shall be evidenced by a light, buzzer, or the equivalent.

64.3 During the test, all manually-operated switches are to be in the “on” position. One lead of the test equipment is to be connected to the equipment grounding terminal/conductor. The second test lead is to be connected to all supply terminals/conductors including the neutral, either one at a time or all at once. The test is to be conducted with the product fully assembled. It is not intended that the product be unwired, modified, or disassembled for this test; however, the test may be conducted prior to final assembly if the results of the test represent those of the complete product. A part such as a snap cover or a friction-fit knob need not be in place if the part would interfere with the test.

Exception: When the product is provided with a transient-voltage suppressive device complying with the Standard for Surge Protective Devices, UL 1449, the product may be tested before the suppressive device is connected or the circuitry may be rearranged for the test to minimize the risk of component damage.

RATINGS

65 Cord-Connected Products

65.1 A cord-connected product shall be rated in volts, amperes, and frequency in hertz.

66 Permanently-Connected Products

66.1 A permanently-connected product shall be rated in volts, amperes, and frequency in hertz, and shall include the number of wires (excluding the green grounding conductor) required in the supply circuit. The rating shall include the minimum supply conductor ampacity and the ampere rating of the supply conductor overcurrent protective device. The number of phases shall be included if the product is for use on a polyphase circuit. The voltage may be a single voltage or voltage range. A product rated with a voltage range shall include the maximum amperage for the range. A product with more than one voltage shall have an amperage to correspond with each voltage. A product for use with multiple supply circuits shall have a rating for each circuit.

Exception No. 1: A product may specify the rating of the largest motor in volts and amperes and the additional loads in volts and amperes. However, an ampere rating of a motor rated 1/8 horsepower or less or a non-motor load rated 1 ampere or less may be omitted unless such load constitutes the principal load.

Exception No. 2: The rating need not include the number of wires for a unit intended to be connected to a nominal 120-volt source of supply.

Exception No. 3: The supply conductor ampacity and overcurrent protector rating are not required if both the supply conductor ampacity and the supply circuit overcurrent protective device do not exceed 15 amperes.

67 Convertible Products

67.1 A convertible product shall include a rating for cord connection and a rating for permanent connection.

68 Supply Conductor Ampacity and Rating of Overcurrent Protection

68.1 The minimum supply conductor ampacity shall be based on 125 percent of the current rating of the product. The ampere rating of the supply circuit overcurrent protector shall be equal to 125 percent of the ampere rating of the product and shall be a standard rating specified in Table 15.2. When 125 percent of the ampere rating falls between two standard ratings, the next higher standard rating shall be specified. Products with more than one electrical rating shall include a minimum supply conductor ampacity and the ampere rating of the supply circuit overcurrent protective device for each electrical rating.

MARKINGS

69 General

69.1 A unit shall be legibly and permanently marked where readily visible after installation on or inside the service door with:

a) The name, trade name, or trademark of the organization responsible for the product;

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

c) A distinctive catalog or model number;

d) The electrical rating; and

e) "For indoor use only" or "For outdoor use only" or, if appropriate, "For indoor/outdoor use."

69.2 Products manufactured at more than one factory shall be marked to identify the factory location.

69.3 The organizational identification may be in a traceable code if the unit is identified by the brand or trademark owned by a private labeler.

69.4 The date of manufacture may be abbreviated in a date code that shall not require reference to the manufacturer's records to determine the date of manufacture. The repetitive cycle of the date code shall not be less than 10 years.

69.5 A required marking 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 that comply with the Standard for Marking and Labeling Systems, UL 969. External labels on units intended for outdoor use shall comply with the requirements for outdoor labels in UL 969. Markings shall be in the exact words specified or in equally definitive terms except that there shall be no substitution for the word "WARNING."

70 Wiring Diagram

70.1 A wiring diagram shall be attached to each field wiring compartment of a permanently wired and convertible product unless field wiring connections are evident. The wiring diagram may be a paper sticker glued or shellacked inside the field wiring compartment, and shall be marked "Use copper conductors only" or, if appropriate, "Use copper or aluminum conductors."

70.2 A convertible or permanently-connected unit shall be marked to indicate the temperature rating (60° C only, 60/75° C, or 75° C only) of the field-installed conductors for which the equipment has been investigated.

70.3 The wiring diagram for a convertible spa or equipment assembly shall include instructions to convert from cord connection to permanent connection.