



UL 1018

Underwriters Laboratories Inc. Standard for Safety

Electric Aquarium Equipment



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UL Standard for Safety for Electric Aquarium Equipment, UL 1018

Sixth Edition, Dated April 29, 2011

Summary of Topics

This new edition of UL 1018 includes the following changes:

Deletion of Appendix A and the Inclusion of Component Requirements in the Body of the Standard

Addition of Requirements for Evaluating Creepage and Clearance Spacing in Section 23

Addition of Requirements for Submersion Test in Paragraph 48.2

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated December 1, 2010 and February 15, 2011.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

The following table lists the future effective dates with the corresponding reference.

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Future Effective Date	Reference
April 29, 2014	Paragraph 48.2



APRIL 29, 2011

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UL 1018

Standard for Electric Aquarium Equipment

Previous numbered and unnumbered editions of standards covering electric aquarium equipment have been published since April 1978.

First Edition – April, 1978
Second Edition – September, 1984
Third Edition – November, 1990
Fourth Edition – September, 1995
Fifth Edition – March, 2001

Sixth Edition

April 29, 2011

This UL Standard for Safety consists of the Sixth Edition.

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 <http://csds.ul.com>.

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INTRODUCTION

1 Scope

1.1 These requirements cover commercial and household electric equipment for use on or in aquariums in indoor locations at 300 volts or less, in accordance with the National Electrical Code, NFPA 70, such as heaters, pumps, filters, aerators, reflectors, hoods, electrically wired stands, and similar equipment.

1.2 These requirements do not cover:

- a) Illuminators or stands not specifically intended for use with aquariums or
- b) Aquarium tanks except when part of the tank acts as enclosure or water barrier for fittings, such as, but not limited to, filter, heating, or UV units that are integrated into the base or wall of the aquarium tank.

1.3 Aquarium equipment involving tungsten-halogen or high intensity discharge lamps shall comply with the additional applicable requirements specified in the Standard for Portable Electric Luminaires, UL 153.

2 Units of Measurement

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

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

3 Undated References

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

4 Glossary

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

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

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

4.4 **APPLIANCE INLET (MOTOR ATTACHMENT PLUG)** – A male contact device mounted on an end product appliance to provide an integral blade configuration for the connection of an appliance coupler or cord connector.

4.5 **AQUARIUM APPLIANCE** – An appliance falling within the scope of these requirements. Requirements that apply only to specific appliances are identified by reference in the text to such specific appliances.

4.6 **AQUARIUM STAND** – Equipment intended to support an aquarium. Such a stand may contain lamps for illumination, heater elements to control the temperature of the aquarium, and other aquarium-related appliances and devices.

4.7 **AUTOMATICALLY CONTROLLED** – An appliance is considered to be automatically controlled under any one or more of the following conditions:

- a) If the repeated starting of the appliance, beyond one complete, predetermined cycle of operation to the point where some form of limit switch opens the circuit, is independent of any manual control.
- b) If, during any single, predetermined cycle of operation, a motor is caused to stop and restart one or more times.
- c) If, upon energizing the appliance, the initial starting of a motor is likely to be intentionally delayed beyond conventional starting.
- d) If, during any single, predetermined cycle of operation, automatic changing of the mechanical load is likely to reduce the motor speed sufficiently to reestablish starting winding connections to the supply circuit.

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

4.9 **CONTROL, AUTOMATIC ACTION** – A control in which at least one aspect is non-manual.

4.10 **CONTROL, AUXILIARY** – A device or assembly of devices that provides a functional utility, is not relied upon as an operational or protective control, and therefore is not relied upon for safety. For example, an efficiency control not relied upon to reduce the risk of electric shock, fire, or injury to persons during normal or abnormal operation of the end product is considered an auxiliary control.

4.11 **CONTROL, MANUAL** – A device that requires direct human interaction to activate or rest the control.

4.12 **CONTROL, OPERATING** – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, a thermostat, the failure of which a thermal cutout/limiter or another layer of protection would mitigate the potential hazard, is considered an operating control. Operating controls are also referred to as “regulating controls”.

4.13 **CONTROL, PROTECTIVE** – A device or assembly of devices, the operation of which is intended to reduce the risk of electric shock, fire or injury to persons during reasonably anticipated abnormal operation of the appliance. For example, a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control. Protective controls are also referred to as “limiting controls” and “safety controls.”

Note – During the evaluation of the protective control/circuit, the protective functions are verified under normal and single-fault conditions of the control.

4.14 CONTROL, TYPE 1 ACTION – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence has not been declared and tested under this standard.

4.15 CONTROL, TYPE 2 ACTION – The actuation of an automatic control for which the manufacturing deviation and the drift (tolerance before and after certain conditions) of its operating value, operating time, or operating sequence have been declared and tested under this standard.

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

4.17 REMOTELY CONTROLLED – An appliance is considered remotely controlled if it is not within sight of the operator at the location of the starting switch or other device.

4.18 USER SERVICING – Any form of servicing of an appliance that may be performed by personnel other than those who have been trained to maintain the particular appliance. Examples include:

- a) Resetting or replacement of circuit breakers, fuses, and lamps that are accessible without the use of tools.
- b) Replacement of removable lamps with or without the use of tools.
- c) Routine operating adjustments necessary to adapt the appliance for different intended functions.
- d) Routine cleaning, and maintenance of components such as filters and diffusers.

CONSTRUCTION

5 Frame and Enclosure

5.1 General

5.1.1 An appliance shall be formed and assembled so that it shall have the strength and rigidity necessary to resist the abuses to which it is likely to be subjected. There shall be no likelihood 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.

5.1.2 The enclosure of an appliance, other than a reflector, shall be such that water will not contact live parts when the appliance is subjected to the Resistance to Overflow Test, Section 59, to simulate conditions that might occur during routine use. All accessories required for operation shall remain in place during the test. The Leakage Current Test, Section 38, shall be used to determine whether water has contacted any live part.

5.2 Thickness of metal

5.2.1 For unreinforced, flat surfaces in general, cast metal shall not be less than 1/8 inch (3.2 mm) thick. Malleable iron shall not be less than 3/32 inch (2.4 mm) thick. Die cast metal shall not be less than 5/64 inch (2 mm) thick if the surface is curved, ribbed, or otherwise reinforced, or if the shape or size (or both) of the surface is such that equivalent mechanical strength is provided.

5.2.2 An enclosure of sheet metal other than a hood or reflector shall be evaluated with regard to the size, shape, and thickness of the metal. Consideration shall be given to the intended use of the complete appliance. The use of sheet steel having a thickness of less than 0.026 inch (0.66 mm) if uncoated, or 0.029 inch (0.74 mm) if galvanized, or of nonferrous metal having a thickness of less than 0.036 inch (0.91 mm) is not recommended.

Exception: It is acceptable for a relatively small area or surface that is curved or otherwise reinforced to be less than the specified thickness. A form of construction that uses metal thinner than specified may be used if found to provide equivalent physical strength and protection.

5.2.3 The thickness of sheet metal in an aquarium hood or reflector shall not be less than indicated in Table 5.1.

5.2.4 The maximum dimension specified in Table 5.1 is considered to be:

- a) The diameter of a circular appliance,
- b) The longest diameter of an elliptical appliance,
- c) The longest side of a triangular appliance,
- d) The diagonal of a rectangular appliance, or
- e) The longest diagonal of a multisided appliance.

Table 5.1
Minimum sheet metal thicknesses for aquarium reflectors

Type of metal	Where used	Minimum acceptable thickness when maximum dimension ^a is:			
		36 inches (914 mm) or less,		More than 36 inches (914 mm),	
		inch	(mm)	inch	(mm)
Stainless steel	At lampholders	0.015	0.38	0.018	0.46
	Elsewhere in reflectors	0.013	0.33	0.018	0.46
Plated steel	At lampholders	0.015	0.38	0.018	0.46
	Elsewhere in reflectors	0.015	0.38	0.018	0.46
Aluminum, brass, or copper	At lampholders	0.025	0.64	0.032	0.81
	Elsewhere in reflectors	0.020	0.51	0.025	0.64

^a In accordance with 5.2.4.

5.2.5 Table 5.1 applies to any single surface or single flat sheet. A rigid member consisting of 1/2 by 1/2 inch (12.7 by 12.7 mm) 90 degree angle strips formed of sheet steel not less than 0.032 inch (0.81 mm) thick, or flat steel bars not less than 3/8 inch (9.5 mm) wide and 1/8 inch (3.2 mm) thick can be used to reinforce and divide a large area into sections for which lighter metal may be used. Such reinforcement,

unless along the longer dimension of the surface, shall be secured to the adjacent sides of the enclosure. A single piece of sheet metal that is corner bent to form an angle of not more than 120 degrees is considered to be reinforced along the bend, and its thickness may be based on the length of the largest flat surface involved.

5.2.6 The thickness of metal is not specified for a purely ornamental part or for a reflector part not relied upon to enclose wiring or support a live part. A part relied upon to reduce the risk of a reflector falling into an aquarium tank is not considered ornamental.

5.2.7 There is no minimum thickness specified for a reflective strip utilized as a heat sink for a reflector; however, the means of adhesion of the strip to the frame shall be investigated as described in 60.1 – 60.3.

5.3 Barriers

5.3.1 The enclosure of a remotely or automatically controlled appliance, or one intended to operate unattended, shall reduce the risk of molten metal, burning insulation, flaming particles, and the like falling on combustible surfaces or materials, including the surface upon which the appliance is supported.

5.3.2 The requirement in 5.3.1 necessitates the use of a barrier of combustion-resistant material:

a) Under a motor unless one of the following items applies:

- 1) The structural parts of the motor or of the appliance provide what is determined to be 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 appliance when the motor is energized under each of the following fault conditions:
 - 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.)
- 3) The motor is provided with a thermal motor protector (a protective device that is sensitive to temperature and current). It shall prevent the temperature of the motor windings from becoming more than 125°C (257°F) under the maximum load conditions under which the motor will run without causing the protector to cycle. It shall also prevent the motor windings from becoming more than 150°C (302°F) with the rotor of the motor locked.
- 4) The motor complies with the requirements for impedance-protected motors in the Standard for Overheating Protection for Motors, UL 2111.

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

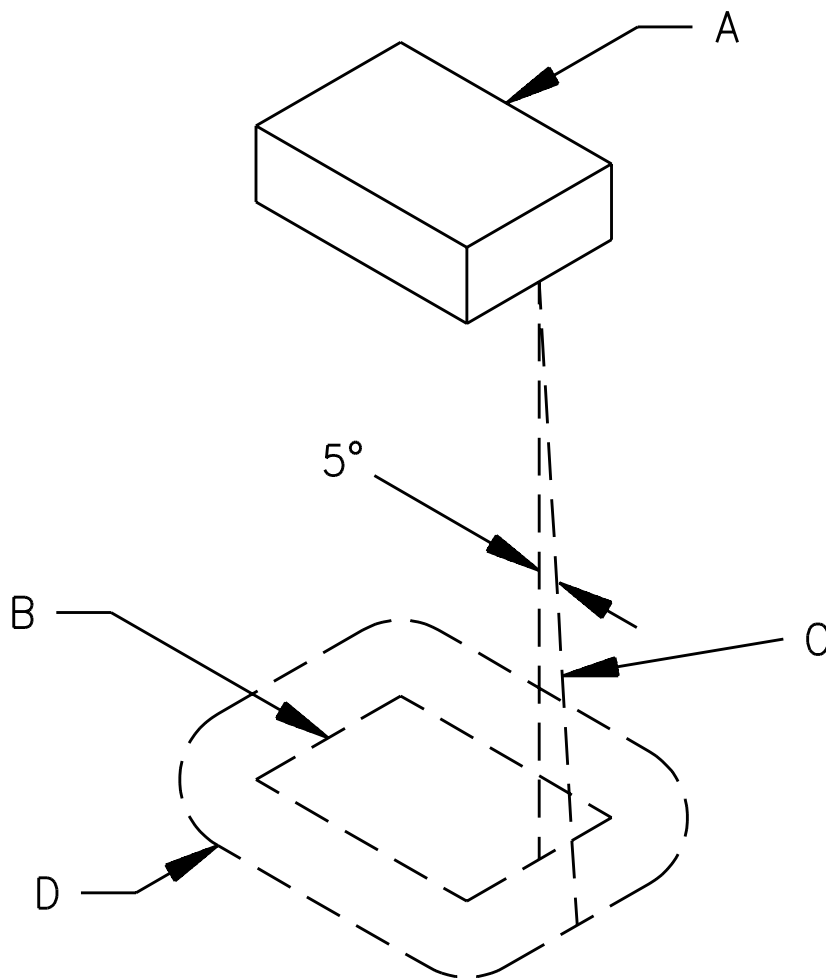
5.3.3 The requirement in 5.3.1 will also necessitate that a switch, relay, solenoid, or similar device be individually and completely enclosed unless it can be shown that:

- a) Failure of the component would not result in a risk of fire, electric shock, or other injury to persons or
- b) There are no openings in the bottom of the appliance overall enclosure.

Exception: A terminal of a switch, relay, solenoid, or a similar device may protrude from such an individual enclosure.

5.3.4 The barrier mentioned in 5.3.2 shall be horizontal, shall be located as indicated in Figure 5.1, and shall have an area not less than that shown in the figure. Openings for drainage, ventilation, and similar needs may be provided in the barrier if they do not permit molten metal, burning insulation, or like materials to fall on combustible material.

Figure 5.1
Location and extent of barrier



EB120A

A – Region to be shielded by barrier. This consists of the entire component if it is not otherwise shielded and consists 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 which traces out minimum area of barrier. When moving, the line is always:

- a) Tangent to the component,
- b) 5 degrees from the vertical, and
- c) Oriented so 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.

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5.4 Polymeric material

5.4.1 A polymeric enclosure material shall be investigated in accordance with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. The ball impact value referred to in UL 746C shall be 5 foot-pounds force (6.78 J) in all cases.

5.4.2 A polymeric material used for parts other than the enclosure in aquarium equipment shall be evaluated in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

5.4.3 Among the factors that shall be taken into consideration when judging the acceptability of magnesium and nonmetallic material are resistance to:

- a) Mechanical damage,
- b) Impact,
- c) Moisture absorption,
- d) Combustion,
- e) Distortion at temperatures to which the material may be subjected under conditions of normal or abnormal use, and
- f) Aging, where the material may be exposed to ultraviolet light (from an ultraviolet lamp bulb, for example), or other similar exposure.

5.4.4 A polymeric appliance material enclosing uninsulated live parts or live parts having insulation less than 0.028 inch (0.71 mm) thick or equivalent, shall comply with the Polymeric Enclosure Tests (mold stress, impact, strain relief, etc.) detailed in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C and shall have a flammability class determined in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94 as follows:

- a) Class 5VA for fixed or stationary appliances or for an appliance that is permanently installed.

Exception: In lieu of the required 5VA flame rating for stationary or permanently installed appliances, the polymeric enclosure may be subjected to the 127 mm end-product flame test in accordance with UL 746C.

- b) Class V-2 minimum for all other aquarium appliances.

Exception No. 1: In lieu of the required V2 flame rating for all other aquarium appliances, the polymeric enclosure may be subjected to the 12 mm or 20 mm end-product flame test in accordance with UL 746C.

Exception No. 2: In lieu of the required V2 flame rating for household aquarium appliances, the polymeric enclosure may be comprised of HB rated materials if the household aquarium equipment is found to comply with the requirements for UL 746C, Portable Unattended Household Equipment - Alternate Path. The appliance shall be marked to indicate it is suitable for household use only.

5.4.5 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.

6 Component Specifications

6.1 General

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

- a) Comply with the requirements for that component as indicated in 6.2 – 6.25;
- b) Be used in accordance with its rating(s) established for the intended conditions of use;
- c) Be used within its established use limitations or conditions of acceptability;
- d) Additionally comply with the applicable requirements of this end product standard; and
- e) Not contain mercury. Fluorescent lamps are exempt.

Note – 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.

Exception No. 1: A component of a product covered by this standard is not required to comply with a specific component requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product; 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.*

Exception No. 2: A component complying with a UL component standard other than those cited in 6.2 – 6.25 is acceptable if:

- a) The component also complies with the applicable component standard of 6.2 – 6.25; or*
- b) The component standard:*
 - 1) Is compatible with the ampacity and overcurrent protection requirements of the National Electrical Code, ANSI/NFPA 70, where appropriate;*
 - 2) Considers long-term thermal properties of polymeric insulating materials in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B; and*
 - 3) Any use limitations of the other component standard is identified and appropriately accommodated in the end use application. For example, a component used in a household application, but intended for industrial use and complying with the relevant component standard may assume user expertise not common in household applications.*

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6.1.2 A component that is also intended to perform other functions, such as over current protection, ground-fault circuit-interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable UL standard(s) that cover devices that provide those functions.

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

6.1.3 A component not anticipated by the requirements of this standard, not specifically covered by the component standards of 6.2 – 6.25, and that involves a potential risk of electric shock, fire, or personal injury, shall be additionally investigated in accordance with the applicable UL standard, and shall comply with 6.1.1 (b) – (d).

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

6.2 Attachment plugs, receptacles, connectors, and terminals

6.2.1 Attachment plugs, receptacles, appliance couplers, appliance inlets (motor attachment plugs), and appliance (flatiron) plugs, shall comply with the Standard for Attachment Plugs and Receptacles, UL 498. See 6.2.9.

Exception No. 1: Attachment plugs and appliance couplers integral to cord sets or power supply cords are covered under the requirements of the Standard for Cord Sets and Power-Supply Cords, UL 817 and need not comply with UL 498.

Exception No. 2: A fabricated pin terminal assembly(ies) need not comply with UL 498 if it complies with Current-Carrying Parts, Section 16, Insulating Material, Section 18, and Spacings, Section 22.

6.2.2 Quick-connect terminals, both connectors and tabs, for use with one or two 22 – 10 AWG copper conductors, having nominal widths of 0.110, 0.125, 0.187, 0.205, and 0.250 inch (2.8, 3.2, 4.8, 5.2, and 6.3 mm), intended for internal wiring connections in appliances, or for the field termination of conductors to the appliance, shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310.

Exception: Other sizes of quick-connect terminals shall be investigated with respect to crimp pull out, insertion-withdrawal, temperature rise, and all tests shall be conducted in accordance with UL 310.

6.2.3 Single and multipole connectors for use in data, signal, control and power applications within and between electrical equipment, and that are intended for factory assembly to copper or copper alloy conductors, or for factory assembly to printed wiring boards, shall comply with the Standard for Component Connectors for Use in Data, Signal, Control and Power Applications, UL 1977. See 6.2.9.

6.2.4 Wire connectors shall comply with the Standard for Wiring Connectors, UL 486A-486B.

6.2.5 Splicing wire connectors shall comply with the Standard for Splicing Wire Connectors, UL 486C.

6.2.6 Multi-pole splicing wire connectors that are intended to facilitate the connection of hard-wired utilization equipment to the branch-circuit conductors of buildings shall comply with the Standard for Insulated Multi-Pole Splicing Wire Connectors, UL 2459. See 6.2.9.

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

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

Exception: A fabricated part performing the function of a terminal block need not comply with UL 1059 if the part complies with the requirements of Wiring terminals and leads, 10.3.3, Current-Carrying Parts, Section 16, Insulating Material, Section 18, and Spacings, Section 22. This exception does not apply to protective conductor terminal blocks.

6.2.9 Female devices (such as receptacles, appliance couplers, and connectors) that are intended, or that may be used, to interrupt current in the end product, shall be suitably rated for current interruption of the specific type of load, when evaluated with its mating plug or connector. For example, an appliance coupler that can be used to interrupt the current of a motor load shall have a suitable horsepower rating when tested with its mating plug.

6.3 Batteries and battery chargers

6.3.1 A lithium ion (Li-On) single cell battery shall comply with the requirements for secondary lithium cells in the Standard for Lithium Batteries, UL 1642. A lithium ion multiple cell battery, and a lithium ion battery pack, shall comply with the applicable requirements for secondary lithium cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

6.3.2 Rechargeable nickel cadmium (Ni-Cad) cells and battery packs shall comply with the applicable construction and performance requirements of this end product standard.

6.3.3 Rechargeable nickel metal-hydride (Ni-MH) battery cells and packs shall comply with construction and performance requirements of this end product standard, or the applicable requirements for secondary cells or battery packs in the Standard for Household and Commercial Batteries, UL 2054.

6.3.4 Primary batteries (non-rechargeable) that comply with the relevant UL Standard and Component Specifications, General, 6.1, are considered to fulfill the requirements of this Standard.

6.3.5 A Class 2 battery charger shall comply with one of the following:

- a) Standard for Class 2 Power Units, UL 1310 or
- b) Standard for Information Technology Equipment, Part 1: General Requirements, UL 60950-1, with an output marked "Class 2", or that complies with the limited power source (LPS) requirements and is marked "LPS".

6.3.6 A non-Class 2 battery charger shall comply with one of the following:

- a) Standard for Power Units Other Than Class 2, UL 1012 or
- b) Standard for Information Technology Equipment, Part 1: General Requirements, UL 60950-1.

6.4 Boxes and raceways

6.4.1 Electrical boxes and the associated bushings and fittings, and raceways, of the types specified in Chapter 3 of the National Electrical Code, ANSI/NFPA 70 and that comply with the relevant UL standard (such as the Standard for Metallic Outlet Boxes, UL 514A, the Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C, the Standard for Cover Plates for Flush-Mounted Wiring Devices, UL 514D) and Component Specifications, General, 6.1, are considered to fulfill the requirements of this Standard.

6.5 Capacitors and filters

6.5.1 The component requirements for a capacitor are not specified. A capacitor complying with the Standard for Capacitors, UL 810, is considered to fulfill the requirements of 29.1.

6.5.2 Electromagnetic interference filters with integral enclosures that comply with the Standard for Electromagnetic Interference Filters, UL 1283, are considered to fulfill the requirements of 29.1.

6.6 Controls

6.6.1 General

6.6.1.1 Auxiliary controls shall be evaluated using the applicable requirements of this end product standard and the parameters in Controls – End Product Test Parameters, Section 27.

6.6.1.2 Operating (regulating) controls shall be evaluated using the applicable component standard requirements specified in 6.6.2 – 6.6.7, and if applicable, the parameters in Controls – End Product Test Parameters, Section 27, unless otherwise specified in this end product standard.

6.6.1.3 Operating controls that rely upon software for the normal operation of the end product where deviation or drift of the control may result in a hazard, such as a speed control unexpectedly changing its output, shall comply with the:

- a) Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, and the Standard for Software in Programmable Components, UL 1998 or
- b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

6.6.1.4 Protective (limiting) controls shall be evaluated using the applicable component standard requirements specified in 6.6.2 – 6.6.7, and if applicable, the parameters in Controls – End Product Test Parameters, Section 27, unless otherwise specified in this end product standard.

6.6.1.5 Solid-state protective controls that do not rely upon software as a protective component shall comply with the:

- a) Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 or
- b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1 except Clause H 11.12 (Controls using software).

6.6.1.6 Protective controls that rely upon software as a protective component shall comply with the:

- a) Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, and the Standard for Software in Programmable Components, UL 1998 or
- b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

6.6.1.7 An electronic, non-protective control that is simple in design need only be subjected to the applicable requirements of this end-product standard. A control that does not include an integrated circuit or microprocessor, but does consist of a discrete switching device, capacitors, transistors, and resistors, is considered simple in design. See Abnormal Operation Test, Section 46.

6.6.2 Electromechanical and electronic controls

6.6.2.1 A control, other than as specified in 6.6.3 – 6.6.7, shall comply with the:

- a) Standard for Solid-State Controls for Appliances, UL 244A;
- b) Standard for Temperature-Indicating and –Regulating Equipment, UL 873; or
- c) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

6.6.3 Liquid level controls

6.6.3.1 A liquid level control shall comply with the:

- a) Standard for Solid-State Controls for Appliances, UL 244A;
- b) Standard for Temperature-Indicating and –Regulating Equipment, UL 873;
- c) Standard for Industrial Control Equipment, UL 508.
- d) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1; and the:
 - 1) Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Water Level Controls of the Float Type for Household and Similar Applications, UL 60730-2-16A or
 - 2) Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Automatic Electrical Water and Air Flow Sensing Controls, Including Mechanical Requirements, UL 60730-2-18. or

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6.6.4 Motor and speed controls

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

- a) Standard for Solid-State Controls for Appliances, UL 244A;
- b) Standard for Temperature-Indicating and –Regulating Equipment, UL 873;
- c) Standard for Industrial Control Equipment, UL 508;
- d) Standard for Power Conversion Equipment, UL 508C; or
- e) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

6.6.5 Pressure controls

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

- a) Standard for Temperature-Indicating and –Regulating Equipment, UL 873;
- c) Standard for Industrial Control Equipment, UL 508; or
- c) 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.

6.6.6 Temperature controls

6.6.6.1 A temperature control shall comply with the:

- a) Standard for Solid-State Controls for Appliances, UL 244A;
- b) Standard for Temperature-Indicating and –Regulating Equipment, UL 873;
- c) Standard for Industrial Control Equipment, UL 508; or
- d) 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.

6.6.6.2 A temperature sensing positive temperature coefficient (PTC) or negative temperature coefficient (NTC) thermistor, that performs the same function as an operating or protective control shall comply with the Standard for Thermistor-Type Devices, UL 1434.

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

6.6.7 Timer Controls

6.6.7.1 A timer control shall comply with the:

- a) Standard for Solid-State Controls for Appliances, UL 244A or
- b) 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 Timers and Time Switches, UL 60730-2-7.

6.7 Cords, cables, and internal wiring

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

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

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

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

- a) Standard for Thermoset-Insulated Wires and Cables, UL 44;*
- b) Standard for Thermoplastic-Insulated Wires and Cables, UL 83;*
- c) Standard for Fixture Wire, UL 66; or*
- d) The appropriate UL Standard(s) for other insulated conductor types specified in Chapter 3 (Wiring Methods and Materials) of NFPA 70.*

Exception No. 2: : Insulated conductors for specialty applications (e.g. data processing or communications) and located in a low-voltage circuit not involving the risk of fire or personal injury need not comply with UL 758.

6.8 Cord reels

6.8.1 A cord reel shall comply with the special-use cord reel requirements of the Standard for Cord Reels, UL 355.

6.9 Film-coated wire (magnet wire)

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

6.9.2 Film coated wire in intimate combination with one or more insulators, and incorporated in an insulation system rated Class 120 (E) or higher, shall comply with the magnet wire requirements in the Standard for Systems of Insulating Materials – General, UL 1446.

6.10 Gaskets and seals

6.10.1 Gaskets and seals that comply with the Standard for Gaskets and Seals, UL 157, are considered to fulfill the requirements of Aging Test on Seal Materials, Section 57.

6.11 Ground-fault, arc-fault, and leakage current Detectors/Interrupters

6.11.1 Ground-fault circuit-interrupters (GFCI) for protection against electrical shock shall comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943. The following statement, or equivalent, shall be included as a marking near the GFCI, or as an instruction in the manual: "Press the TEST button (then RESET button) every month to assure proper operation. "

6.11.2 Appliance-leakage-current interrupters (ALCI) for protection against electrical shock shall comply with the Standard for Appliance-Leakage-Current Interrupters, UL 943B.

Note – An ALCI is not considered an acceptable substitute for a GFCI when the National Electrical Code, ANSI/NFPA 70 requires a GFCI.

6.11.3 Equipment ground-fault protective devices shall comply with the Standard for Ground-Fault Sensing and Relaying Equipment, UL 1053, and the applicable requirements of the Standard for Ground-Fault Circuit-Interrupters, UL 943.

6.11.4 Arc-fault circuit-interrupters (AFCI) shall comply with the Standard for Arc-Fault Circuit Interrupters, UL 1699. See Controls – End Product Test Parameters, Section 27.

6.11.5 Leakage-current detector-interrupters (LCDI) and any shielded cord between the LCDI and appliance shall comply with the Standard for Arc-Fault Circuit Interrupters, UL 1699. See Controls – End Product Test Parameters, Section 27.

6.12 Heaters and heating elements

6.12.1 Electric resistance heating elements shall comply with the construction requirements of the:

- a) Standard for Electric Heating Appliances, UL 499; or
- b) Standard for Sheathed Heating Elements, UL 1030.

Exception No. 1: Heating wire (e.g. rope heater) that complies with the Standard for Appliance Wiring Material, UL 758, and the requirements of this end product standard are considered to fulfill this requirement.

Exception No. 2: Open wire resistance elements are not required to comply with the construction requirements detailed in UL 499.

6.12.2 Thermistor-type heaters (e.g. PTC and NTC heaters) shall comply with the Standard for Thermistor-Type Devices, UL 1434.

6.13 Insulation systems

6.13.1 Materials used in a Class 105 (A) insulation system shall comply with Insulation systems, 20.3.

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

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

6.14 Light sources and associated components

6.14.1 Lampholders and indicating lamps shall comply with the Standard for Lampholders, UL 496.

Exception: Lampholders forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

6.14.2 Lighting ballasts shall comply with the:

- a) Standard for Fluorescent-Lamp Ballasts, UL 935; or
- b) Standard for High-Intensity-Discharge Lamp Ballasts, UL 1029.

Exception No. 1: Ballasts forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

Exception No. 2: Ballasts for other light sources shall comply with the appropriate UL Standard(s).

6.14.3 Light emitting diode (LED) light sources shall comply with the Standard for Light Emitting Diode (LED) Light Sources For Use In Lighting Products, UL 8750.

Exception No. 1: LED light sources forming part of a luminaire that complies with an appropriate UL luminaire standard are considered to fulfill this requirement.

Exception No. 2: Individual LED light sources mounted on printed wiring boards and intended for indicating purposes need not comply with UL 8750, but shall comply with the applicable requirements of this Standard.

6.15 Marking and labeling systems

6.15.1 A marking and labeling system shall comply with the Standard for Marking and Labeling Systems, UL 969 under the specified environmental conditions.

6.16 Motors and motor overload protection

6.16.1 General

6.16.1.1 A motor located in a low voltage circuit shall be evaluated for the risk of fire, electric shock and personal injury in accordance with the applicable requirements of this end product standard.

6.16.1.2 A motor requiring a motor insulation system greater than Class 105 (A) due to the temperatures obtained on the motor windings during the testing of the appliance, shall comply with 6.16.2.1.

6.16.1.3 An oil-filled motor or a motor employing integral ground insulation of any insulation class shall comply with 6.16.2.1.

6.16.2 Motors

6.16.2.1 A motor as specified in 6.16.1.2 or 6.16.1.3 shall comply with:

- a) The Standard for Electric Motors, UL 1004 or
- b) The Standard for Rotating Electrical Machines – General Requirements, UL 1004-1.

6.16.2.2 A motor other than as specified in 6.16.1.2 or 6.16.1.3 shall comply with:

- a) 6.16.2.1 or
- b) The construction and performance requirements of this Standard, when tested in conjunction with the appliance, and the following additional construction requirements of the Standard for Rotating Electrical Machines – General Requirements, UL 1004-1:
 - 1) A motor with aluminum windings shall comply with the Protection Against Corrosion requirements of UL 1004-1 with respect to galvanic compatibility. All winding terminals shall be suitable for the connection of aluminum windings and the motor leads.
 - 2) The resilient mounting of a motor in an appliance provided with grounding shall comply with UL 1004-1, if the dead metal parts of the motor are accessible during normal use or servicing of the appliance or conductively connected to accessible dead metal parts of the appliance.

3) A starting or running capacitor of a motor in a permanently-connected appliance shall comply with UL 1004-1 with respect to the maximum available fault current.

4) The motor shall be marked with the motor manufacturer name or identification, catalog or model number, rated voltage and rated frequency

6.16.2.3 With respect to 6.16.2.2(a), the following exceptions may be applied:

a) Motor controls shall be evaluated in accordance with Controls, 6.6.

b) Parts of phenolic material in direct contact with live parts other than magnet wire, such as brush holders or commutator insulation, shall be considered suitable without further evaluation of the material's electrical insulating properties.

6.16.3 Motor overload protection

6.16.3.1 Thermal protection devices integral with the motor shall comply with the:

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

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

c) 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 Thermal Motor Protectors, UL 60730-2-2.

6.16.3.2 Impedance protection shall comply with the:

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

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

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

6.16.3.4 Except as indicated in 6.16.3.3, electronically protected motor circuits shall comply with one of the following:

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

b) 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 Thermal Motor Protectors, UL 60730-2-2, or the Standard for Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Temperature Sensing Controls, UL 60730-2-9. If software is relied upon to perform a safety function, it shall be considered software Class B.

Exception: Compliance with the above standards is not required for an electronically protected motor circuit if there is no risk of fire, electric shock, or casualty hazard during abnormal testing with the motor electronic circuit rendered ineffective.

6.17 Overcurrent protection

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

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

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

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

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

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

6.17.6 Fusing resistors shall comply with the Standard for Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances, UL 1412.

6.18 Polymeric materials and enclosures

6.18.1 Unless otherwise specified in this end product standard, polymeric electrical insulating materials and enclosures shall comply with the applicable requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

6.18.2 Metallized or painted polymeric parts or enclosures shall comply with the applicable requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. This requirement is not applicable to exterior surfaces of polymeric enclosure materials or parts provided that the metallized coating or paint does not offer a continuous path for an internal flame to propagate externally.

6.19 Power supplies

6.19.1 A Class 2 power supply shall comply with one of the following:

- a) Standard for Class 2 Power Units, UL 1310; or
- b) Standard for Information Technology Equipment, Part 1: General Requirements, UL 60950-1, with an output marked "Class 2", or that complies with the limited power source (LPS) requirements and is marked "LPS".

6.19.2 A non-Class 2 power supply shall comply with one of the following:

- a) Standard for Power Units Other Than Class 2, UL 1012 or
- b) Standard for Information Technology Equipment, Part 1: General Requirements, UL 60950-1.

6.20 Printed wiring boards

6.20.1 Printed wiring boards, including the coatings, shall comply with the Standard for Printed Wiring Boards, UL 796.

Exception: A printed-wiring board in a Class 2 nonsafety circuit is not required to comply with the bonding requirements in UL 796 if the board is separated from parts of other circuits such that loosening of the bond between the foil conductor and the base material will not result in the foil conductors or components coming in contact with parts of other circuits of the control or of the end-use product.

6.20.2 A printed-wiring board containing circuitry in a line-connected circuit or a safety circuit shall comply with the direct-support requirements for insulating materials in Internal Wiring, Section 14.

6.20.3 Unless otherwise specified, the flammability class and temperature rating shall be that specified for insulating materials in Internal Wiring, Section 14.

6.21 Semiconductors and small electronic components

6.21.1 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with the Standard for Electrically Isolated Semiconductor Devices, UL 1557. The dielectric voltage withstand tests required by UL 1557 shall be conducted applying the criteria of the Dielectric Voltage-Withstand Test, Section 42.

6.21.2 An optical isolator that is relied upon to provide isolation between primary and secondary circuits or between other circuits as required by this end product standard shall comply with the Standard for Optical Isolators, UL 1577. The dielectric voltage withstand tests required by UL 1577 shall be conducted applying the criteria of the Dielectric Voltage-Withstand Test, Section 42.

6.21.3 Except as specified in 6.21.4, component requirements are not specified for small electronic components on printed wiring boards, including diodes, transistors, resistors, inductors, integrated circuits, and capacitors not directly connected to the supply source.

6.21.4 Where an electronic component is determined to be a critical component during the testing of Abnormal Operation Test, Section 46, one of the following standards shall be applied. See Protective controls (limiting controls), 27.4, for the test parameters to be used.

- a) Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991, including its Follow-Up Program; and as applicable, the Standard for Software in Programmable Components, UL 1998 for controls that rely upon software as a protective component; or
- b) Standard for Automatic Electrical Controls for Household and Similar Use; Part 1: General Requirements, UL 60730-1.

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

6.21.6 A critical component may also be identified using a failure-mode and effect analysis (FMEA) in accordance with Failure-Mode and Effect Analysis (FMEA), Section 7 of the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991.

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

6.22 Supplemental insulation, insulating bushings, and assembly aids

6.22.1 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) are not specified unless the insulation or device is required to fulfill the requirements of 15.3 or a performance requirement of this Standard. In such cases:

- a) Insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510.
- b) Sleeving shall comply with the Standard for Coated Electrical Sleeving, UL 1441.
- c) Tubing shall comply with the Standard for Extruded Insulating Tubing, UL 224.

6.22.2 Wire positioning devices shall comply with Separation of Circuits, Section 17 and Insulating Material, Section 18. A device that complies with the Standard for Positioning Devices, UL 1565, is considered to fulfill this requirement.

6.22.3 Insulating bushings that comply with Construction, General, Section 6, and the Standard for Insulating Bushings, UL 635, are considered to fulfill the requirements of this Standard. Tests specified in this Standard (e.g. Strain Relief Test, Section 50) may still need to be performed to confirm the combination of the insulating bushing and the supporting part are suitable.

6.23 Switches

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

- a) Standard for Special-Use Switches, UL 1054;
- b) Standard for Switches for Appliances – Part 1: General Requirements, UL 61058-1;
- c) Standard for General-Use Snap Switches, UL 20; or
- d) Standard for Nonindustrial Photoelectric Switches for Lighting Control, UL 773A.

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

6.23.2 A clock-operated switch, in which the switching contacts are actuated by a clock-work, by a gear-train, by electrically-wound spring motors, by electric clock-type motors, or by equivalent arrangements shall comply with one of the following:

- a) Standard for Clock-Operated Switches, UL 917 or
- b) 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 Timers and Time Switches, UL 60730-2-7.

6.23.3 A timer or time switch, incorporating electronic timing circuits or switching circuits, with or without separable contacts, shall comply with the requirements for an operating control with Type 1 action for 6000 cycles of operation, or as a manual control for 5000 cycles of operation, in accordance with the following:

- a) Standard for Solid-State Controls for Appliances, UL 244A; or
- b) 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 Timers and Time Switches, UL 60730-2-7.

6.23.4 A timer or time switch, incorporating electronic timing circuits or switching circuits, with or without separable contacts, that functions as a protective control, shall comply with the requirements for a protective control; see 6.6.1.3.

6.24 Transformers

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

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

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

6.24.2 Class 2 and Class 3 transformers shall comply with 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.

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

6.25 Valves (electrically operated) and solenoids

6.25.1 Electrically operated valves shall comply with the:

- a) Standard for Electrically Operated Valves, UL 429 or
- b) 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 Electrically Operated Water Valves, Including Mechanical Requirements, UL 60730-2-8.

Exception: Automatic valves intended for use with natural gas, manufactured gas, LP-gas or LP-gas-air mixtures shall comply with ANSI Z21.21/CSA 6.5, Automatic Valves for Gas Appliances.

6.25.2 Solenoids shall comply with the applicable construction and performance requirements of this Standard.

7 Mechanical Assembly

7.1 An appliance shall be assembled so that it will not be affected adversely by the vibration of operation. Brush caps shall be tightly threaded or otherwise constructed to reduce the risk of loosening.

7.2 A switch, lampholder, or any similar component shall be mounted securely and restrained from turning.

Exception No. 1: The requirement that a switch be restrained 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 subject to forces that tend to rotate it during operation.)*
- b) The means for mounting the switch make it unlikely that operation of the switch will loosen it.*
- c) The electrical spacings would not be reduced below the minimum required values if the switch should rotate.*
- d) The operation of the switch is by mechanical means rather than by persons.*

Exception No. 2: A lampholder of the type in which the lamp is not replaceable (such as a neon pilot or indicator lamp in which the lamp is sealed in a nonrenewable jewel) is not required to be restrained from turning if such rotation does not reduce spacings below those required.

7.3 A properly sized and applied lock washer is acceptable as a means to restrain turning of a stem-mounted switch.

7.4 An aquarium appliance intended to be installed on a tank shall be tested as described in 56.1, and provided with instructions in accordance with 70.3.3.

Exception: The test described in 56.1 is not required to be performed if the shape or size of the appliance is such that it cannot fall into the tank in any position.

7.5 An uninsulated live part shall be secured to the base or surface so that it is restrained from turning or shifting in position during use if such motion may result in a reduction of spacings below the minimum required values.