UL 979

STANDARD FOR SAFETY

Water Treatment Appliances

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UL Standard for Safety for Water Treatment Appliances, UL 979

Third Edition, Dated August 26, 2024

Summary of Topics

This new edition of UL 979 dated August 26, 2024 incorporates editorial changes including renumbering and reformatting to align with current style, as well as the following changes in requirements:

– Revisions based on the latest version of UL 4200A; Section 9

– Editorial corrections; 38.1, 38.3, 48.7

– Replacement of the reference to the 5th Edition of UL 60335-1 by an undated reference to UL 60335-1; 30.5.2

– Addition of a reference to UL 60730-2-22; 6.16.4.1

– Updates to Section 5, Undated References, and the addition of a list of Referenced Standards; 5.2

– Clarification of the Frequency During Tests; 39.1

The new requirements are substantially in accordance with Proposal(s) on this subject dated March 8, 2024, June 8, 2024, and July 19, 2024.

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Standard for Water Treatment Appliances

First Edition – May, 2005
Second Edition – September, 2016

Third Edition

August 26, 2024

This UL Standard for Safety consists of the Third Edition.

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

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INTRODUCTION

1 Scope

1.1 These requirements cover electrically operated water treatment appliances for household, commercial use, and industrial use. These appliances are intended for installation and use in accordance with the National Electrical Code, NFPA 70, and are rated 600 V or less.

1.2 These requirements cover appliances utilizing features that treat water through the use of cation exchange water softeners, ionization, filters, ultraviolet radiation, ozone generation, and reverse osmosis.

1.3 These requirements do not cover water treatment appliances for use with pools or spas, water distillers, aquariums, or other equipment connected to plumbing that is covered by individual requirements.

1.4 These requirements do not cover appliances for use in hazardous locations as defined in the National Electrical Code, NFPA 70.

1.5 These requirements do not cover the aesthetic effects or the effectiveness of water treatment.

2 Glossary

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

2.2 APPLIANCE – A collective term to designate all products covered by this Standard.

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

2.4 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.

2.5 APPLIANCE, PERMANENTLY-CONNECTED – An appliance intended to be permanently connected electrically.

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

2.7 APPLIANCE, PORTABLE – An appliance with the following characteristics:

a) The appliance is cord- and plug-connected;

b) The operating literature and installation instructions illustrate connecting the water lines to the output of a sink-type faucet. The connection to the sink-type faucet does not require tools, or the appliance is provided with its own water container;

c) The operating literature and installation instructions do not portray placing the appliance under the cabinet or a dedicated space, and they only illustrate placing the appliance on a counter top near the sink; and

d) The appliance has feet or keyhole slots and does not have non-keyhole slots or other more permanent mounting means.

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2.8 APPLIANCE, STATIONARY – An appliance connected to plumbing and not expected to be moved except during servicing or storage. A stationary appliance may have wheels or casters.

2.9 BARRIER – A partition for the insulation or isolation of electric circuits, for the isolation of electric arcs, or for isolation of moving parts or hot surfaces. In this respect, a barrier may serve as a portion of an enclosure or as a functional part.

2.10 CAPACITOR, CLASS X – Capacitor or RC unit of a type suitable for use in situations where failure of the capacitor or RC unit would not lead to danger of electrical shock but could result in a risk of fire. Examples would be units connected phase to phase or phase to neutral.

NOTE 1: X1 capacitors are generally used in circuits of permanently connected appliances. However, if the appliance is provided with a separate surge protective device that limits the impulse voltage to ≤ 2.5KV, an X2 capacitor is permitted.

NOTE 2: X2 capacitors are generally used in circuits of cord-connected appliances.

2.11 CAPACITOR, CLASS Y – Capacitor or RC unit of a type suitable for use in situations where failure of the capacitor could lead to danger of electric shock. Examples would be capacitors connected across the primary and secondary circuits where electrical isolation is required to prevent an electric shock or between hazardous live parts and accessible parts.

NOTE 1: Y1 capacitors are used in circuits where the prevention of electric shock is afforded solely by the isolation provided by the capacitor. Two Y2 capacitors connected in series is considered to provide the same level of protection as one Y1 capacitor.

NOTE 2: Y2 capacitors are used where the prevention of electric shock is provided by the combination of the capacitor and earth ground for circuits operating at voltages ≥ 150V and ≤ 300V.

NOTE 3: Y4 capacitors are used where the prevention of electric shock is provided by the combination of the capacitor and earth ground for circuits operating at voltages ≤ 150V.

2.12 CIRCUIT, HIGH-VOLTAGE – A circuit involving a potential of more than 600 V.

2.13 CIRCUIT, LINE-VOLTAGE – A circuit involving a potential of not more than 600 V and having circuit characteristics in excess of those of a low-voltage circuit.

2.14 CIRCUIT, LOW-VOLTAGE – A circuit involving a peak open-circuit potential of not more than 42.4 V supplied by a primary battery, by a Class 2 transformer, or by a combination of a transformer and a fixed impedance that as a unit, complies with all performance requirements for a Class 2 transformer. A circuit derived from a line-voltage circuit by connecting a resistance in series with the supply circuit as a means of limiting the voltage and current, is not considered to be a low-voltage circuit.

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

2.16 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.

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

2.18 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.

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

2.20 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 risk of electric shock, fire, or injury to persons, is considered an operating control.

2.21 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 normal and 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. (During the testing of the protective control/circuit, the protective functions are verified under normal and single-fault conditions of the control.)

2.22 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.

2.23 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.

2.24 DANGEROUS MALFUNCTION – Unintended operation of the appliance that may impair safety. Operating Control functions whose failure would result in a Dangerous Malfunction would be considered Safety Critical Functions. See 30.5.

NOTE: Control functions whose failure might result in a Dangerous Malfunction would include:

a) Unexpected operation of the appliance where the operation would result in risk of electric shock, fire or mechanical hazard.

b) Unattended energization of a heating appliance where the user has placed flammable materials near the appliance based on the assumption the appliance would remain off.

2.25 ENCLOSURE – A part that by itself or in conjunction with barriers:

a) Renders inaccessible all or any parts that may otherwise present a risk of electric shock;

b) Reduces the risk of contact with parts that may cause injury to persons; or

c) Prevents propagation of flame due to electrical disturbances occurring within. A cabinet that serves to enclose electrical components or wiring is considered to be an enclosure.

2.26 FIELD WIRING TERMINAL – A terminal to which a supply or other wire can be connected by an installer in the field.

2.27 MAXIMUM WORKING PRESSURE – The maximum operating pressure recommended by the manufacturer.

2.28 MOTOR, ACCESSIBLE – A motor that may be contacted without opening or removing any part and that is located so as to be accessible to contact.

2.29 MOTOR, INACCESSIBLE – A motor that is accessible only by opening or removing a part of the outer enclosure, such as a panel or service door, which can be removed without the use of tools, or a

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motor that is located in such a position or is otherwise guarded or enclosed so that it is unlikely to be contacted.

2.30 OPPOSITE POLARITY – A difference of potential between two points, where shorting of these two points would result in a condition involving overload, rupturing of printed wiring-board tracks, components or fuses, and similar components.

2.31 PRESSURE-RELIEF DEVICE – A pressure-actuated valve or rupture member designed to relieve excessive pressures automatically.

2.32 PRESSURE VESSEL – A component of the system intended to hold water under pressure higher than atmospheric pressure.

2.33 RISK OF ELECTRIC SHOCK – A risk of electric shock is considered to exist within a circuit unless the circuit meets one of the following criteria. The circuit shall be supplied by an isolating source such that the following items are met:

a) The following voltage limits shall be met:

1) The voltage does not exceed 30 V rms;

2) The voltage does not exceed 42.4 V peak;

3) The voltage does not exceed 60 V dc continuous; or

4) The voltage does not exceed 24.8 V peak for DC interrupted at a rate of 200 Hz or less with approximately 50 % duty cycle.

b) When protective impedance is used, the current available through a 1500 ohm resistor between the part or parts and either pole of the supply source does not exceed 0.7 mA peak or 2 mA DC:

1) For frequencies exceeding 1 kHz, the limit of 0.7 mA (peak value) is multiplied by the value of the frequency in kHz but shall not exceed 70 mA peak;

2) For voltages over 42.4 V peak and up to and including 450 V (peak value) the capacitance shall not exceed 0.1 μF.

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

2.35 ULTRAVIOLET (UV) LAMP SYSTEM – Appliances that directly generates ultraviolet radiation within the equipment for cleaning and disinfection purposes.

2.36 ULTRAVIOLET (UV) RADIATION – Electromagnetic energy with a wavelength of 200 – 400 nm.

NOTE: For ultraviolet (UV) radiation, the range between 100 nm and 400 nm is commonly subdivided into: UV-A (Near UV), from 315 nm to 400 nm; UV-B, from 280 nm to 315 nm; and UV-C, from 100 nm to 280 nm.

2.37 USER SERVICING – Any form of servicing that can be performed by personnel other than those who are trained to maintain the particular appliance. Some examples of user servicing are:

a) Attaching accessories by means of attachment plugs and receptacles or by means of other separable connectors;

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b) Replacing lamps and fuses and resetting circuit breakers located in an operator-access area unless the lamps, fuses, or circuit breakers are marked to indicate replacement or resetting only by qualified service personnel;

c) Making routine operating adjustments necessary to adapt the appliances for its different intended functions; and

d) Any operation described or implied in the operator's manual, whether or not tools are required.

2.38 VOLTAGE FOLDBACK – A circuit design feature intended to protect the power supply output transistors. When overcurrent is drawn by the load, the supply reduces the output voltage and current to within the safe power dissipation limit of the output transistors.

2.39 WORKING VOLTAGE – The highest voltage to which the insulation or the component under consideration is, or can be, subjected when the equipment is operating under conditions of normal use. Overvoltages that originate outside the equipment are not taken into account.

3 Safety Critical Functions

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

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

a) Reliable as defined as being able to maintain the SCF in the event of single defined component faults; and

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

3.3 Functions specified in the table represent the common safety critical circuit functions of typical water treatment units. It is not intended to represent all possible Safety Critical Functions.

Table 3.1
Safety Critical Functions

Function[a]	Hazard	Location of parameters and tests
Motor running overload protection	Risk of fire or electric shock	34.3
Motor locked rotor protection	Risk of fire or electric shock	34.3
Motor short circuit protection	Risk of fire or electric shock	34.3

[a] Functions specified in the table represent the common safety critical circuit functions of water treatment equipment. 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 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.

4 Units of Measurement

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

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5 Referenced Publications

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

5.2 The following publications are referenced in this Standard:

ASTM A 653/A 653M, *Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*

ASTM A90/A90M, *Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles With Zinc or Zinc-Alloy Coatings*

ASTM E230/E230M, *Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

IEC 60127-1, *Miniature Fuses – Part 1 Definitions for Miniature Fuses and General Requirements for Miniature Fuse-Sinks*

IEC 61000-4-2, *Electromagnetic Compatibility (EMC) – Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity Test*

IEC 61000-4-3, *Electromagnetic Compatibility (EMC) – Part 4-3: Testing and Measurement Techniques – Radiated, Radio-frequency, Electromagnetic Field Immunity Test*

IEC 61000-4-4, *Electromagnetic Compatibility (EMC) – Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/burst Immunity Test*

IEC 61000-4-5, *Electromagnetic Compatibility (EMC) – Part 4-5: Testing and Measurement Techniques – Surge Immunity Test*

IEC 61000-4-6, *Electromagnetic Compatibility (EMC) – Part 4-6: Testing and Measurement Techniques – Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields*

IEC 61000-4-11, *Electromagnetic Compatibility (EMC) – Part 4-11: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests for Equipment with Input Current up to 16 A per Phase*

IEC 61000-4-13, *Electromagnetic Compatibility (EMC) – Part 4-13: Testing and Measurement Techniques – Harmonics and Interharmonics Including Mains Signaling at ac Power Port, Low Frequency Immunity Tests*

IEC 62471, *Photobiological Safety of Lamps and Lamp System*

IES RP-271, *Standard for Recommended Practice for Photobiological Safety for Lamps and Lamp Systems – General Requirements*

NFPA 70, *National Electrical Code*

UL 20, *General-Use Snap Switches*

UL 50, *Enclosures for Electrical Equipment, Non-Environmental Considerations*

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UL 62, *Flexible Cords and Cables*

UL 66, *Fixture Wire*

UL 83, *Thermoplastic-Insulated Wires and Cables*

UL 94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

UL 101, *Leakage Current for Utilization Equipment*

UL 157, *Gaskets and Seals*

UL 224, *Extruded Insulating Tubing*

UL 248-1, *Low-Voltage Fuses – Part 1: General Requirements*

UL 310, *Electrical Quick-Connect Terminals*

UL 429, *Electrically Operated Valves*

UL 486A-486B, *Wire Connectors*

UL 486C, *Splicing Wire Connectors*

UL 486E, *Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors*

UL 489, *Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures*

UL 489A, *Circuit Breakers For Use in Communications Equipment*

UL 496, *Lampholders*

UL 498, *Attachment Plugs and Receptacles*

UL 499, *Electric Heating Appliances*

UL 507, *Electric Fans*

UL 508, *Industrial Control Equipment*

UL 508A, *Industrial Control Panels*

UL 510, *Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape*

UL 514A, *Metallic Outlet Boxes*

UL 514C, *Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers*

UL 514D, *Cover Plates for Flush-Mounted Wiring Devices*

UL 542, *Fluorescent Lamp Starters*

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UL 635, *Insulating Bushings*

UL 746A, *Polymeric Materials – Short Term Property Evaluations*

UL 746B, *Polymeric Materials – Long Term Property Evaluations*

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

UL 758, *Appliance Wiring Material*

UL 773A, *Nonindustrial Photoelectric Switches for Lighting Control*

UL 778, *Motor-Operated Water Pumps*

UL 796, *Printed Wiring Boards*

UL 810, *Capacitors*

UL 817, *Cord Sets and Power-Supply Cords*

UL 840, *Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment*

UL 867, *Electrostatic Air Cleaners*

UL 935, *Fluorescent-Lamp Ballasts*

UL 943, *Ground-Fault Circuit-Interrupters*

UL 943B, *Appliance Leakage-Current Interrupters*

UL 969, *Marking and Labeling Systems*

UL 1004-1, *Rotating Electrical Machines – General Requirements*

UL 1004-2, *Impedance Protected Motors*

UL 1004-3, *Thermally Protected Motors*

UL 1004-7, *Electronically Protected Motors*

UL 1012, *Power Units Other Than Class 2*

UL 1029, *High-Intensity-Discharge Lamp Ballasts*

UL 1030, *Sheathed Heating Elements*

UL 1053, *Ground-Fault Sensing and Relaying Equipment*

UL 1059, *Terminal Blocks*

UL 1077, *Supplementary Protectors for Use in Electrical Equipment*

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UL 1097, *Double Insulation Systems for Use in Electrical Equipment*

UL 1283, *Electromagnetic Interference Filters*

UL 1310, *Class 2 Power Units*

UL 1412, *Fusing Resistors and Temperature-Limited Resistors for Radio- and Television-Type Appliances*

UL 1434, *Thermistor-Type Devices*

UL 1441, *Coated Electrical Sleeving*

UL 1446, *Systems of Insulating Materials – General*

UL 1449, *Surge Protective Devices*

UL 1557, *Electrically Isolated Semiconductor Devices*

UL 1565, *Positioning Devices*

UL 1577, *Optical Isolators*

UL 1581, *Reference Standard for Electrical Wires, Cables, and Flexible Cords*

UL 1642, *Lithium Batteries*

UL 1699, *Arc-Fault Circuit-Interrupters*

UL 1977, *Component Connectors for Use in Data, Signal, Control and Power Applications*

UL 2054, *Household and Commercial Batteries*

UL 2111, *Overheating Protection for Motors*

UL 2353, *Single- and Multi-Layer Insulated Winding Wire*

UL 2459, *Insulated Multi-Pole Splicing Wire Connectors*

UL 4200A, *Products Incorporating Button Batteries or Coin Cell Batteries*

UL 4248-1, *Fuseholders – Part 1: General Requirements*

UL 4248-9, *Fuseholders – Part 9: Class K*

UL 5085-1, *Low Voltage Transformers – Part 1: General Requirements*

UL 5085-2, *Low Voltage Transformers – Part 2: General Purpose Transformers*

UL 5085-3, *Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers*

UL 8750, *Light Emitting Diode (LED) Equipment for Use in Lighting Products*

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UL 60065, *Audio, Video and Similar Electronic Apparatus – Safety Requirements*

UL 60335-1, *Household and Similar Electrical Appliances, Part 1: General Requirements*

UL 60384-14, *Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains*

UL 60691, *Thermal-Links – Requirements and Application Guide*

UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*

UL 60730-2-2, *Automatic Electrical Controls for Household and Similar Use; Part 2: Particular Requirements for Thermal Motor Protectors*

UL 60730-2-6, *Automatic Electrical Controls – Part 2-6: Particular Requirements for Automatic Electrical Pressure Sensing Controls Including Mechanical Requirements*

UL 60730-2-7, *Automatic Electrical Controls – Part 2-7: Particular Requirements for Timers and Time Switches*

UL 60730-2-8, *Automatic Electrical Controls – Part 2-8: Particular Requirements for Electrically Operated Water Valves, Including Mechanical Requirements*

UL 60730-2-9, *Automatic Electrical Controls – Part 2-9: Particular Requirements for Temperature Sensing Controls*

UL 60730-2-15, *Automatic Electrical Controls – Part 2-15: Particular Requirements for Automatic Electrical Air Flow, Water Flow and Water Level Sensing Controls*

UL 60730-2-18, *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 60730-2-22, *Automatic Electrical Controls – Part 2-22: Particular Requirements for Thermal Motor Protectors*

UL 60947-1, *Low-Voltage Switchgear and Controlgear – Part 1: General Rules*

UL 60947-4-1, *Low-Voltage Switchgear and Controlgear – Part 4-1: Contactors and Motor-Starters – Electromechanical Contactors and Motor-Starters*

UL 60950-1, *Information Technology Equipment – Safety – Part 1: General Requirements*

UL 61010-1, *Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements*

UL 61058-1, *Switches for Appliances – Part 1: General Requirements*

UL 61800-5-1, *Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy*

UL 62368-1, *Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements*

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CONSTRUCTION

6 Components

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 – 6.26;

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; and

d) Additionally comply with the applicable requirements of this end product standard.

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

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

b) Is superseded by a requirement in this Standard; or

c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.

Exception No. 2: A component that complies with a UL component standard other than those specified in 6.2 – 6.26 is acceptable if the UL component standard:

a) Is compatible with the ampacity and overcurrent protection requirements in NFPA 70, where applicable;

b) Considers long-term thermal properties of polymeric insulating materials in accordance with UL 746B; and

c) Any use limitations of the other component standard are 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.

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 UL component standard(s) need not be applied.

6.1.3 A component not anticipated by the requirements of this end product standard, not specifically covered by the component standards in 6.2 – 6.26, and that involves a 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).

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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 the requirements of this end product standard.

6.1.5 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.

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 UL 498. See 6.2.9.

Exception No. 1: Attachment plugs and appliance couplers integral to cord sets or power supply cords are investigated in accordance with the requirements of UL 817 are not required to comply with UL 498.

Exception No. 2: A fabricated pin terminal assembly need not comply with UL 498 if it complies with Accessibility, Section 10; Mechanical Assembly, Section 13; Live Parts, Section 17; Electrical Insulation, Section 18; Spacings, Section 22, of this end product standard; and the applicable performance requirements when tested in the end product.

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 2.8, 3.2, 4.8, 5.2, and 6.3 mm (0.110, 0.125, 0.187, 0.205, and 0.250 inch), intended for internal wiring connections in appliances, or for the field termination of conductors to the appliance, shall comply with UL 310.

Exception No. 1: 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.

Exception No. 2: A connector that complies with UL 310 may be used with an appropriately sized tab that complies with Tabs Used in Electrical Quick-Connect Terminals, Section 20. The connector is the part of a quick-connect terminal that is pushed onto the male tab, and the tab is the part that receives the female connector.

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 UL 1977. See 6.2.9.

6.2.4 Wire connectors shall comply with UL 486A-486B.

6.2.5 Splicing wire connectors shall comply with 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 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 UL 486E.

6.2.8 Terminal blocks shall comply with 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, 15.3; Live Parts, Section 17;

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Electrical Insulation, Section 18; and Spacings, Section 22, of this end product standard; and the applicable performance requirements when tested in the end product. 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 UL 1642.

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 the applicable construction and performance requirements of this end product standard, or the applicable requirements for secondary cells or battery packs in UL 2054.

6.3.4 Primary batteries (non-rechargeable) that comply with the relevant UL standard and 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) UL 1310;

b) UL 60950-1, with an output marked "Class 2", or that complies with the limited power source (LPS) requirements and is marked "LPS"; or

c) UL 62368-1, that complies with the limited power source requirements (LPS) requirements and is marked "LPS."

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

a) UL 1012;

b) UL 60950-1; or

c) UL 62368-1.

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, Wiring Methods and Materials, of NFPA 70 and that comply with the relevant UL standard (such as UL 514A, UL 514C, UL 514D) and 6.1 are considered to comply with the requirements of this end product standard.

6.5 Capacitors and filters

6.5.1 The component requirements for a capacitor are not specified. A capacitor complying with UL 810 is considered to comply with the requirements of 24.1.

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6.5.2 Electromagnetic interference filters with integral enclosures that comply with one of the following standards are considered to comply with the requirements of 24.1.

a) UL 1283; or

b) UL 60384-14.

6.5.3 Capacitors that comply with UL 60384-14, are considered to comply with the requirements of 24.1.

6.6 Controls

6.6.1 General

6.6.1.1 Auxiliary controls shall be evaluated to the requirements in (a) or (b):

a) Using the applicable requirements of this end product standard and the requirements in Controls – End Product Test Parameters, Section 29; or

b) Using the requirements for Electronic Circuits Evaluated to UL 60335-1, based requirements, Section 30.

6.6.1.2 Operating (regulating) controls shall be evaluated to either the requirements in (a) or (b):

a) Using the applicable component standard requirements specified in 6.6.2 – 6.6.7 and the parameters in Controls – End Product Test Parameters, Section 29, unless otherwise specified in this end product standard; or

b) Using the requirements for Electronic Circuits Evaluated to UL 60335-1, based requirements, Section 30.

6.6.1.3 Operating controls that rely upon software for the normal operation of the end product that manage a Safety Critical Function shall comply with:

a) UL 60730-1, or

b) Using the requirements for UL 60335-1, based requirements, Section 30.

6.6.1.4 Protective Electronic Circuits shall be evaluated to either the requirements in (a) or (b):

a) 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 29, unless otherwise specified in this end product standard; or

b) Using the requirements for UL 60335-1, based requirements, Section 30.

6.6.1.5 Solid-state Protective Electronic Circuits that do not rely upon software as a protective component shall comply with:

a) UL 60730-1, except for the Controls Using Software requirements; or

b) Using the requirements for Electronic Circuits Evaluated to UL 60335-1, based requirements, Section 30.

6.6.1.6 Solid-state Protective Electronic Circuits that rely upon software as a protective component shall comply with:

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a) UL 60730-1; or

b) Using the requirements for Electronic Circuits Evaluated to UL 60335-1, based requirements, Section 30.

6.6.1.7 An electronic, auxiliary or operating control (e.g. a non-protective control) that does not manage a Safety Critical Function, need only be subjected to the applicable requirements of this end product standard.

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:

a) UL 60730-1; or

b) Using the requirements for Electronic Circuits Evaluated to UL 60335-1, based requirements, Section 30.

6.6.3 Liquid level controls

6.6.3.1 A liquid level control shall comply with:

a) UL 508; or

b) UL 60730-1; and

1) UL 60730-2-15; or

2) UL 60730-2-18; or

c) Using the requirements for Electronic Circuits Evaluated to UL 60335-1, based requirements, Section 30.

6.6.3.2 A switch employed as part of a water level detection mechanism is to comply with one of the switch standards specified in 6.23.

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:

a) UL 508;

b) UL 61800-5-1;

c) UL 60730-1;

d) UL 60947-1, and UL 60947-4-1; or

e) Using the requirements for Electronic Circuits Evaluated to UL 60335-1, based requirements, Section 30.

6.6.5 Pressure controls

6.6.5.1 A pressure control shall comply with one of the following; see also 27.8 and 27.9:

a) UL 508;

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b) UL 60730-1; and UL 60730-2-6; or

c) Using the requirements for Electronic Circuits Evaluated to UL 60335-1, based requirements, Section 30.

6.6.6 Temperature controls

6.6.6.1 A temperature control shall comply with:

a) UL 508;

b) UL 60730-1; and UL 60730-2-9; or

c) Using the requirements for Electronic Circuits Evaluated to UL 60335-1, based requirements, Section 30.

6.6.6.2 A temperature sensing positive temperature coefficient (PTC) or a negative temperature coefficient (NTC) thermistor, that is part of a circuit that manages a Safety Critical Function shall comply with:

a) UL 60730-1; and UL 60730-2-9, with Annex J; or

b) UL 1434.

6.6.6.3 A thermal cutoff shall comply with UL 60691.

6.6.7 Timer controls

6.6.7.1 A timer control shall comply with:

a) UL 60730-1; and UL 60730-2-7; or

b) Using the requirements for Electronic Circuits Evaluated to UL 60335-1, based requirements, Section 30.

6.7 Cords, cables, and internal wiring

6.7.1 A cord set or power supply cord shall comply with UL 817.

6.7.2 Flexible cords and cables shall comply with UL 62. Flexible cord and cables are considered to fulfill this requirement when preassembled in a cord set or power supply cord complying with UL 817.

6.7.3 Internal wiring composed of insulated conductors shall comply with UL 758.

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

a) The Standard for Thermoset-Insulated Wires and Cables, UL 44;

b) UL 83;

c) UL 66; or

d) The applicable UL standard(s) for other insulated conductor types specified in Chapter 3, Wiring Methods and Materials, of NFPA 70.

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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 Cooling fan

6.8.1 A cooling (ventilation) fan shall comply with the applicable requirements of UL 507.

Exception: A component type motor-operated fan that is completely enclosed within the end product enclosure that complies with the applicable requirements of this end product standard, is considered to comply with 6.8.1.

6.8.2 Low voltage component fans that comply with UL 507, are considered to fulfill the requirements in Motors, Section 34.

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 UL 1446.

6.10 Gaskets and seals

6.10.1 Gaskets and seals that comply with the applicable requirements of UL 157, are considered to fulfill the requirements in Seals, Gaskets, and Diaphragms, Section 33.

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 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 UL 943B. An ALCI is not considered an acceptable substitute for a GFCI when a GFCI is required by NFPA 70.

6.11.3 Equipment ground-fault protective devices shall comply with UL 1053, and the applicable requirements of UL 943.

6.11.4 Arc-fault circuit-interrupters (AFCI) shall comply with UL 1699. See Arc-Fault and Leakage Current Detectors/Interrupters, Section 35.

6.11.5 Leakage-current detector-interrupters (LCDI) and any shielded cord between the LCDI and appliance shall comply with UL 1699. See Arc-Fault and Leakage Current Detectors/Interrupters, Section 35.

6.12 Heaters and heating elements

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

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a) UL 499; or

b) UL 1030.

Exception: Heating wire (e.g. rope heater) that complies with UL 758, and the requirements of this end product standard are considered to fulfill this requirement.

6.12.2 Thermistor-type heaters (e.g. PTC and NTC heaters) shall comply with UL 1434.

6.13 Insulation systems

6.13.1 Materials used in a Class 105 (A) insulation system shall comply with 25.3.

6.13.2 Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with UL 1446.

6.13.3 All insulation systems employing integral ground insulation shall comply with the requirements specified in UL 1446.

6.14 Light sources and associated components

6.14.1 Lampholders and indicating lamps with integral lamp/lampholder (e.g. neon pilot lamp) shall comply with UL 496.

Exception: Lampholders forming part of a luminaire that complies with the applicable UL luminaire standard are considered to comply with this requirement.

6.14.2 Lighting ballasts shall comply with:

a) UL 935; or

b) UL 1029.

Exception No. 1: Ballasts forming part of a luminaire that complies with the applicable UL luminaire standard are considered to comply with this requirement.

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

6.14.3 Automatic starters for electric discharge lamps shall comply with UL 542. Holders for automatic starters shall comply with UL 496.

6.14.4 Light emitting diode (LED) light sources shall comply with UL 8750.

Exception No. 1: LED light sources forming part of a luminaire that complies with the applicable UL luminaire standard are considered to comply with 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 end product standard.

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6.15 Marking and labeling systems

6.15.1 A marking and labeling system shall comply with UL 969, under the specified environmental conditions; see 70.2.

6.16 Motors and motor overload protection

6.16.1 General

6.16.1.1 General-purpose type motors having a NEMA frame size shall comply with the requirements specified in 6.16.2. This includes fractional HP motors rated up to 1 HP (typically NEMA frame sizes 42, 48, or 56), and integral HP motors rated 1 HP and greater (typically NEMA frame sizes 140 – 449T).

6.16.1.2 Motors not enclosed, or partially enclosed, by the end product enclosure shall comply with the requirements specified in 6.16.2.

6.16.1.3 Component type motors completely enclosed within the end product enclosure shall comply with the requirements specified in 6.16.2 or 6.16.3.

6.16.1.4 Motors located in a low voltage circuit are evaluated for the risk of fire and personal injury in accordance with the applicable requirements of this end product standard.

6.16.2 General-purpose type motors

6.16.2.1 A general-purpose type motor shall comply with UL 1004-1.

6.16.3 Component type motors

6.16.3.1 Component type motors shall comply with either 6.16.3.2 or 6.16.3.3.

6.16.3.2 The motor shall comply with UL 1004-1, except as noted in Table 6.1.

Table 6.1
Superseded Requirements

UL 1004-1 exempted requirement	Superseded by the requirements in this Standard
Current and Horsepower Relation	Paragraph 34.3.3
Cord-Connected Motors	Section 14
Factory Wiring Terminals and Leads	Section 19
Electrical Insulation	Section 18
Non-Metallic Functional Parts	Sections 8, 18, 34
Solid-State Controls, 7.2	Paragraph 6.6
Non-metallic enclosure thermal aging, 9.1.4	Paragraph 8.8
Motor enclosure, 9.2 – 9.4	Section 8
Grounding	Section 16
Ventilation Openings: only applicable where the openings are on surfaces considered to be the appliance enclosure.	Section 8

Table 6.1 Continued on Next Page

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Table 6.1 Continued

UL 1004-1 exempted requirement	Superseded by the requirements in this Standard
Accessibility of Uninsulated Live Parts, Film-Coated Wire, and Moving Parts	Section 10
Protection Against Corrosion	Section 11
Available fault current ratings for motor start and running capacitors, 26.6: not applicable for cord and plug connected appliances.	Section 24
Switch: not applicable to centrifugal starting switches	Section 28
With the exception of Resilient Elastomer Mounting and Electrolytic Capacitor Tests requirements, the performance tests in UL 1004-1 are not applicable	All applicable performance tests
Only the following marking requirements are applicable: manufacturer's name or identification; rated voltage; rated frequency; number of phases if greater than 1; and multi-speed motors, other than a shaded-pole or a permanent-split-capacitor motor, shall be marked with the amperes and horsepower at each speed.	Paragraph 70.6

6.16.3.3 The motor shall comply with the applicable component requirements for Components, Section 6, the following construction requirements, and the applicable performance requirements (when tested in conjunction with the end product), of this end product standard:

a) Protection Against Corrosion, Section 11;

b) Terminal Compartment, Section 15 (15.2);

c) Grounding, Section 16;

d) Electrical Insulation, Section 18;

e) Internal Wiring, Section 19;

f) Spacings, Section 22;

g) Capacitors, Section 24; and

h) Motors, Section 34.

6.16.4 Motor overload protection

6.16.4.1 Thermal protection devices integral with the motor shall comply with one of the following:

a) UL 2111;

b) UL 1004-3; or

c) UL 60730-1; and

1) UL 60730-2-2; or

2) UL 60730-2-22;

in conjunction with UL 1004-3 (to evaluate the motor-protector combination).

6.16.4.2 Impedance protection shall comply with UL 1004-2.

6.16.4.3 Electronic protection integral to the motor shall comply with UL 1004-7.

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6.16.4.4 Except as indicated in 6.16.4.3, electronically protected motor circuits shall comply with UL 60730-1. If software is relied upon to perform a safety function, it shall be considered software Class B. See Motor and Speed Controls, 6.6.4, for basic control requirements.

Exception: Compliance with this requirement is not required for an electronically protected motor circuit if there is no risk of fire, electric shock, or personal injury hazard during abnormal testing with the motor electronic circuit rendered ineffective; compliance with the applicable requirements of this end product standard is then required.

6.17 Overcurrent protection

6.17.1 Fuses shall comply with UL 248-1; and the applicable Part 2 (e.g. UL 248-5). Defined use fuses that comply with UL 248-1 and another applicable UL standard for fuses are considered to comply with this requirement.

6.17.2 Fuseholders shall comply with UL 4248-1, and the applicable Part 2 (e.g. UL 4248-9).

6.17.3 Circuit breakers shall comply with UL 489.

Exception: Circuit breakers used in telecommunications circuitry that comply with 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 UL 943.

6.17.5 Supplementary protectors shall comply with UL 1077.

6.17.6 Fusing resistors shall comply with UL 1412.

6.18 Polymeric materials

6.18.1 Unless otherwise specified in this end product standard, polymeric electrical insulating materials and enclosures shall comply with the applicable requirements of UL 746C.

6.18.2 Metallized or painted polymeric parts or enclosures shall comply with the applicable requirements of 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) UL 1310;

b) UL 60950-1, with an output marked "Class 2", or that complies with the limited power source (LPS) requirements and is marked "LPS";

c) UL 61010-1, with NEC Class 2 output (output category 2); or

d) UL 62368-1, that complies with the limited power source requirements (LPS) requirements and is marked "LPS."

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

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a) UL 1012;

b) UL 60950-1;

c) UL 61010-1, with NEC Class 1 output (output category 1); or

d) UL 62368-1.

6.20 Printed wiring boards

6.20.1 Printed wiring boards, including the coatings, shall comply with UL 796; see 18.6.

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 UL 746C.

6.20.3 Unless otherwise specified, the flammability class and temperature rating shall be that specified for insulating materials in UL 746C.

6.21 Semiconductors and small electrical and electronic components

6.21.1 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with UL 1557. If considered necessary, the dielectric voltage withstand tests required by UL 1557 shall be conducted applying the criteria of Dielectric Voltage-Withstand Test, Section 46.

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 UL 1577. If considered necessary, the dielectric voltage withstand tests required by UL 1557 shall be conducted applying the criteria of Dielectric Voltage-Withstand Test, Section 46. The dielectric test voltage is to be applied between the input and output terminals of the optical isolator.

6.21.3 Surge protective devices are to comply with UL 1449, and be a type suitable for the end-use application.

6.21.4 Except as specified in 6.21.5, 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.

6.21.5 Where an electronic component is determined to be a critical component during the Component Breakdown Test specified in 47.2, UL 60730-1, shall be applied. See 29.4 for the test parameters to be used.

6.21.6 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.

6.21.7 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 UL 60730-1, Annex H.

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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 19.14 or a performance requirement of this Standard. In such cases:

a) Insulating tape shall comply with UL 510;

b) Sleeving shall comply with UL 1441; or

c) Tubing shall comply with UL 224.

6.22.2 Wire positioning devices shall comply with Electrical Insulation, Section 18, and Separation of Circuits, Section 21. A device that complies with UL 1565, is considered to fulfill this requirement.

6.22.3 Insulating bushings that comply with 6.1 and UL 635 are considered to fulfill the requirements of this Standard. Tests specified in this Standard (e.g. Strain Relief Test) 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) UL 61058-1;

b) UL 20; or

c) UL 773A.

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

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 UL 60730-1, and 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 6,000 cycles of operation, or as a manual control for 5,000 cycles of operation, in accordance with UL 60730-1, and 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 UL 5085-1; and UL 5085-2.

Exception: A transformer that complies with UL 1411, and that is used in a circuit involving an audio or video component complies with the intent of this requirement.

6.24.2 Class 2 and Class 3 transformers shall comply with UL 5085-1; and UL 5085-3.

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

6.25 Valves (electrically operated) and solenoids

6.25.1 Electrically operated valves shall comply with the:

a) UL 429; or

b) UL 60730-1; and 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 the Standard for Automatic Valves for Gas Appliances, ANSI Z21.21a/CSA 6.6.

6.25.2 Solenoids shall comply with the applicable construction and performance requirements of this end product standard, or with the Outline of Investigation for Solenoids, UL 906.

6.26 Water pumps

6.26.1 A motor-operated water pump shall comply with the following UL 778.

Exception: A component type motor-operated pump that is completely enclosed within the end product enclosure that complies with the applicable requirements of this end product standard, is considered to comply with 6.26.1.

6.27 Power-switching semiconductors (mounted to accessible metal parts)

6.27.1 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with UL 1557. It shall have a minimum isolation voltage of 1500 V.

6.28 Thermistors

6.28.1 Thermistors shall comply with UL 1434. The thermistors shall be suitable for the application at the specified electrical and thermal ratings.

7 General

7.1 An appliance shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

7.2 An appliance shall be acceptable for both indoor and outdoor use unless marked for restricted use in accordance with 70.8.

7.3 A waste connection or drain outlet of appliances connected to a potable water system shall be designed and constructed to provide for connection to the sanitary waste system through an air gap of 2 pipe diameters or 1 inch (25.4 mm), whichever is larger.

7.4 A low voltage circuit shall be judged under the requirements for primary circuits in this Standard unless the transformer or power supply that supplies the circuit complies with 31.1 or 31.3.

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8 Frame and Enclosure

8.1 An appliance 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 reduction of spacings, loosening or displacement of parts, or other serious defects.

8.2 An edge, projection, or corner of an enclosure, opening, frame, guard, knob, handle, or similar part, of an appliance shall be smooth and rounded and not sufficiently sharp to cause a cut-type injury when contacted during normal use or maintenance.

8.3 A door or cover of an enclosure shall be provided with a means for securing the door or cover in place in the closed position.

8.4 A device, such as a lampholder, fuseholder, or circuit breaker, of the replaceable type shall be designed and installed so that persons servicing the lamps, fuses, circuit breakers, or other devices will not unintentionally contact any uninsulated live part other than a screwshell or the clips of a fuseholder.

8.5 The enclosure of an appliance shall be complete. The enclosure shall not depend on adjacent walls or equipment to complete the enclosure.

8.6 Mounting holes shall be located or guarded so that nails or similar hangers shall not come in contact with any bare, covered, or uninsulated live part.

8.7 Among the factors to be considered when determining the acceptability of an enclosure are:

a) Physical strength;

b) Resistance to impact;

c) Moisture-absorptive properties;

d) Flammability;

e) Resistance to corrosion;

f) Resistance to distortion at temperatures to which the enclosure is subjected under conditions of intended use;

g) For a sheet-metal enclosure, in addition to the factors in (a) – (f), the size and shape of the metal, the thickness of the metal, and the conditions of intended use;

h) For a nonmetallic enclosure exposed to an ultraviolet radiation weathering source, resistance to degradation from exposure to ultraviolet radiation; and

i) For a nonmetallic enclosure, all of the factors are to be considered with respect to thermal aging.

8.8 A polymeric enclosures shall comply with UL 746C. When determining compliance with UL 746C, the polymeric (including epoxy potting compounds) enclosure shall comply with the following:

a) Material Properties – The material shall comply with the “Material property considerations” in Table 8.1 of UL 746C.

b) Impact Test – A minimum impact of 5 foott-lbf (6.8 J) shall apply to all enclosure materials. In addition to the test requirements specified in UL 746C, any cracking of a polymeric material that

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