



UL 1951

STANDARD FOR SAFETY

Electric Plumbing Accessories

UL Standard for Safety for Electric Plumbing Accessories, UL 1951

Third Edition, Dated March 6, 2025

SUMMARY OF TOPICS

This new Third Edition of ANSI/UL 1951 dated March 6, 2025 include the following changes:

- Revisions to Control Requirements: [5.5.1.4](#), [5.5.2.1](#), [5.5.3.1](#), [5.5.4.1](#), [5.5.5.1](#), [5.5.6.1](#), [5.5.7.1](#), [5.17.2](#), [5.17.3](#), and [19.1](#);***
- Revisions Based on Latest Version of UL 4200A: Section [7.8](#) (title) and [7.8.1](#);***
- Updates to Outdated Referenced Standards, Addition of Alternative References, and Revisions of some Referenced Standards for Enhanced Accuracy throughout the document; and***
- Updates to Section 3 “Undated References” and the Addition of a List of Referenced Standards: [3.1](#)***

The requirements are substantially in accordance with Proposal(s) on this subject dated August 30, 2024, November 22, 2024, and January 17, 2025.

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The most recent designation of ANSI/UL 1951 as an American National Standard (ANSI) occurred on March 6, 2025. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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PART 1 – ALL EQUIPMENT

INTRODUCTION

1 Scope

1.1 These requirements cover equipment connected to or used with plumbing in commercial or household locations. Examples of equipment covered by these requirements are irrigation equipment, sprinkler controls, pedicure spas, water controls located in kitchens and bathrooms, electric faucets, toilets and toilet flushing systems, and non-refrigerated water dispensing equipment for drinking water, connected to plumbing systems or for temporary use with containerized water. All equipment is intended for installation and use in accordance with the National Electrical Code, NFPA 70, and is rated 600 volts or less.

1.2 These requirements do not cover pumps, dishwashers, washing machines, or other equipment connected to plumbing that is covered by individual requirements.

1.3 These requirements do not cover refrigeration systems or controls that regulate water temperature, or equipment for use in hazardous locations as defined in the National Electrical Code, NFPA 70.

2 Units of Measurement

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

2.2 Unless indicated otherwise, all voltage and current values are rms and wattage values are average power.

3 Referenced Publications

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.

3.2 The following publications are referenced in this Standard:

ASME B94.11M, *Twist Drills*

ANSI Z21.22/CSA4.4, *Relief Valves for Hot Water Supply Systems*

ASME B1.20.1, *Standard for Pipe Threads, General Purpose (Inch)*

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

ASTM G152, *Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*

ASTM G153, *Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*

ASTM G155, *Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials*

BPVC-IV, ASME Boiler and Pressure Vessel Code – Rules for Construction of Heating Boilers

CSA C22.2 NO. 0.5, *Standard for Threaded Conduit Entries*

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

IEC 60417, *Graphical symbols for use on equipment*

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 A.C. Power Port, Low Frequency Immunity Tests*

ISA MC96.1, *Temperature Measurement Thermocouples*

NMX-H-146-1996-SCFI, *Unified Screw Threads – Specifications*

NFPA 70, *National Electrical Code*

UL 20, *General-Use Snap Switches*

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 157, *Gaskets and Seals*

UL 224, *Extruded Insulating Tubing*

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

UL 248-5, *Low-Voltage Fuses – Part 5: Class G Fuses*

UL 310, *Electrical Quick-Connect Terminals*

UL 353, *Limit Controls*

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

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 796, *Printed-Wiring Boards*

UL 810, *Capacitors*

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

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

UL 935, *Fluorescent-Lamp Ballasts*

UL 943, *Ground-Fault Circuit-Interrupters*

UL 943B, *Appliance-Leakage-Current Interrupters*

UL 969, *Marking and Labeling Systems*

UL 991, *Tests for Safety Related Controls Employing Solid-State Devices*

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 1059, *Terminal Blocks*

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

UL 1283, *Electromagnetic Interference Filters*

UL 1310, *Class 2 Power Units*

UL 1411, *Transformers and Motor Transformers for Use in Audio-, Radio-, and Television-Type Appliances*

UL 1431, *Personal Hygiene and Health Care Appliances*

UL 1434, *Thermistor-Type Devices*

UL 1441, *Coated Electrical Sleeving*

UL 1446, *Systems of Insulating Materials – General*

UL 1557, *Electrically Isolated Semiconductor Devices*

UL 1565, *Positioning Devices*

UL 1577, *Optical Isolators*

UL 1642, *Lithium Batteries*

UL 1647, *Motor-Operated Massage and Exercise Machines*

UL 1699, *Arc-Fault Circuit-Interrupters*

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

UL 1998, *Software in Programmable Components*

UL 2054, *Household and Commercial Batteries*

UL 2111, *Overheating Protection for Motors*

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

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) Light Sources Equipment for Use in Lighting Products*

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

UL 60335-1, *Household and Similar Electrical Appliances – Safety – 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 60730-2-6, *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 60730-2-16A, *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 60730-2-18, *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 60947-1, *Low-Voltage Switchgear and Controlgear – Part 1: General Rules*

UL 60947-7-1, *Low-Voltage Switchgear And Controlgear – Part 7-1: Ancillary Equipment – Terminal Blocks for Copper Conductors*

UL 60947-7-2, *Low-Voltage Switchgear And Controlgear – Part 7-2: Ancillary Equipment – Protective Conductor Terminal Blocks for Copper Conductors*

UL 60947-7-3, *Low-Voltage Switchgear And Controlgear – Part 7-3: Ancillary Equipment – Safety Requirements for Fuse Terminal Blocks*

UL 60950-1, *Information Technology Equipment – Safety – 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*

4 Glossary

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

4.2 FIELD-WIRING TERMINAL – A terminal to which power supply (including equipment grounding) or control connection will be made in the field when the product is installed as intended. If the wire, to be connected to the terminal, is provided as part of the unit and a pressure terminal, connector, soldering lug, soldered loop, crimped eyelet, or other means for making the connection is factory-assembled to the wire, it is not a field wiring terminal.

4.2.1 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.

4.2.2 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.

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

4.4 CONTROL, AUXILIARY – A device that provides a functional utility but is not relied on as an operational or protective control. The failure of an auxiliary control generally does not cause the operation of a protective control. An example of an auxiliary control is a safety related control where other controls are being relied upon during testing for the safety function. The auxiliary control might more likely function in actual use but for test purposes, it is bypassed.

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

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

4.7 CONTROL, PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of fire, electric shock, or injury to persons during normal and reasonably anticipated abnormal operation of the appliance whereby during the evaluation of the protective control/circuit, the protective functions are verified under normal and single-fault conditions of the control. For example, a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control.

4.8 CONTROL, TYPE 2 ACTION – The actuation of an automatic control of [4.3](#) for which the manufacturing deviation and the drift of its operating value, operating time, or operating sequence have been declared and tested under this end product standard.

4.9 CONTROL, TYPE (2) D.H ACTION – This action is applicable to manual controls (described in [4.5](#) above). A Type D.H action shall be so designed that the contacts cannot be prevented from opening and which may automatically reset to the closed position if the reset means is held in the reset position. The control shall not reset automatically at any temperature above -35 °C with the reset mechanism in the normal position.

4.10 CONTROL, TYPE (2) D.J ACTION – This action is applicable to manual controls (described in [4.6](#) above). A Type D.J action shall be so designed that the contacts cannot be prevented from opening, and the control is not permitted to function as an automatic reset device if the reset means is held in the reset position. The control shall not reset automatically at any temperature above -35 °C.

4.10.1 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.

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.

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

4.12 LOW-VOLTAGE CIRCUIT – A circuit involving a peak open-circuit potential of not more than 42.4 volts supplied by a 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 a low-voltage circuit.

4.13 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 the like.

4.13.1 PEDICURE SPA – An appliance intended for water immersion of feet, usually (but not necessarily) associated with professional pedicure services. A pedicure spa usually has a water circulation/foot massage function and a water heater, and may additionally have heat and massage functions in an integral chair. A pedicure spa may be portable, stationary or be intended to be permanently fixed in place.

4.14 PRIMARY CIRCUITS – The wiring and components that are conductively connected to the supply circuit.

4.14.1 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:

- a) The voltage does not exceed 30 V rms;
- b) The voltage does not exceed 42.4 V peak;
- c) The voltage does not exceed 60 V dc continuous; or
- d) 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.
- e) 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 μ F.

4.15 SAFETY CIRCUIT – A primary or secondary circuit that contains a control relied upon to reduce a risk of fire, electric shock, or injury to persons.

4.15.1 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.

4.16 SECONDARY CIRCUIT – A circuit supplied from a secondary winding of an isolation transformer.

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

- a) Attaching accessories by means of attachment plugs and receptacles or by means of other separable connectors.
- 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 unit for its different intended functions.
- d) Any operation described or implied in the operator's manual, whether or not tools are required.

4.18 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.

4.19 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.

CONSTRUCTION

5 Components

5.1 General

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

- a) Comply with the requirements for that component as indicated in [5.2](#) – [5.21](#);
- 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 a product 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 end product 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 [5.2](#) – [5.21](#) is acceptable if:

- a) *The component also complies with the applicable component standard of [5.2](#) – [5.21](#); or*
- b) *The component standard:*
 - 1) *Is compatible with the ampacity and overcurrent protection requirements NFPA 70, where appropriate;*
 - 2) *Considers long-term thermal properties of polymeric insulating materials in accordance with UL 746B; and*
 - 3) *Any use limitations of the other component UL 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.*

5.1.2 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.

5.1.3 A component that is also intended to perform other functions, such as overcurrent 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 UL standard(s) need not be applied.

5.1.4 A component not anticipated by the requirements of this end product standard, not specifically covered by the component standards of [5.2](#) – [5.21](#), 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 [5.1.1](#) (b) – (d).

5.1.5 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 end product standard.

5.2 Attachment plugs and receptacles

5.2.1 Attachment plugs and receptacles shall comply with UL 498.

Exception No. 1: Attachment plugs integral to cord sets or power supply cords are covered under the requirements of UL 817 and are not required to comply with UL 498.

Exception No. 2: A fabricated pin terminal assembly(ies) is not required to comply with UL 498 if it complies with requirements in Current-Carrying Parts, Section [14](#), Insulating Material, Section [15](#), and Spacings, Section [26](#) of this end product standard.

5.2.2 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.

5.2.3 Female devices (such as receptacles 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.

5.3 Batteries and battery chargers

5.3.1 A lithium ion (Li-On) single cell battery shall comply with the requirements for secondary lithium cells in 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 UL 2054. The unit shall also be marked in accordance with [61.6](#).

5.3.2 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 UL 2054.

5.3.3 Primary batteries (non-rechargeable) that comply with the relevant UL standard and [5.1](#) are considered to comply with the requirements of this end product standard.

5.3.4 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, marked "Class 2" that complies with the limited power source (LPS) requirements and is marked "LPS".

5.3.5 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.

5.4 Capacitors and filters

5.4.1 The component requirements for a capacitor are not specified. A capacitor complying with UL 810, is considered to comply with the requirements of [22.1](#).

5.4.2 Electromagnetic interference filters with integral enclosures that comply with UL 1283, are considered to comply with the requirements of [22.1](#).

5.4.3 A capacitor connected across the line or between line and ground (such as a capacitor for radio-interference elimination) shall be suitable for the voltage involved and comply with UL 60384-14. They shall be rated for the intended application, including operating voltage, subclass, Upper and Lower

Temperature rating. The duration of the damp-heat test shall be 21 days for indoor use appliances and 56 days for appliances permanently installed outdoors.

5.4.3.1 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 $\leq 2.5\text{KV}$, an X2 capacitor is permitted.

5.4.3.2 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.

5.4.3.3 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 $\geq 150\text{V}$ and $\leq 300\text{V}$.

5.4.3.4 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 $\leq 150\text{V}$.

5.5 Controls

5.5.1 General

5.5.1.1 Auxiliary controls shall be evaluated using the applicable requirements of this end product standard and the parameters in Controls – End Product Test Parameters, Section [24](#).

5.5.1.2 Operating (regulating) controls shall be evaluated using the applicable component standard requirements specified in [5.5.2](#) – [5.5.7](#), and if applicable, the test parameters in Controls – End Product Test Parameters, Section [24](#), unless otherwise specified in this end product standard.

5.5.1.3 Protective (limiting) controls shall be evaluated using the applicable component standard requirements specified in [5.5.2](#) – [5.5.7](#), and if applicable, the test parameters in Controls – End Product Test Parameters, Section [24](#), unless otherwise specified in this end product standard.

5.5.1.4 Solid-state protective controls shall comply with one of the following:

- a) UL 991;
- b) UL 60730-1, except Clause H 11.12 (Controls using software).
- c) The Electronic Circuits requirements in Section [25](#).

5.5.1.5 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. Such controls shall comply with the Abnormal Operation Test, Section [56](#).

5.5.2 Controls, electromechanical and electronic

5.5.2.1 A control, other than as specified in [5.5.3](#) – [5.5.7](#), shall comply with UL 60730-1.

5.5.3 Controls, liquid level

5.5.3.1 A liquid level control shall comply with one of the following:

- a) UL 508;

b) UL 60730-1; and one of the following:

- 1) UL 60730-2-16A;
- 2) UL 60730-2-18;
- 3) UL 60730-2-15.

c) The Electronic Circuits requirements in Section [25](#).

5.5.4 Controls, motor and speed

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

- a) UL 508;
- b) UL 61800-5-1;
- c) UL 60730-1.
- d) The Electronic Circuits requirements in Section [25](#).

5.5.4.2 A motor speed control evaluated to UL 61800-5-1 shall not be utilized to provide motor overload protection specified in [20.2](#) – [20.3](#) unless the electronic protection features have additionally been determined to comply with UL 1004-7.

5.5.5 Controls, pressure

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

- a) UL 508, if an operating control;
- b) UL 353, if a protective control;
- c) UL 60730-1; and UL 60730-2-6;
- d) The Electronic Circuits requirements in Section [25](#).

5.5.6 Controls, temperature

5.5.6.1 A temperature control shall comply with one of the following:

- a) UL 508;
- b) UL 60730-1 and UL 60730-2-9.
- c) The Electronic Circuits requirements in Section [25](#).

5.5.6.2 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 UL 1434.

5.5.6.3 A thermal cutoff shall comply with UL 60691.

5.5.7 Controls, timer

5.5.7.1 A timer control shall comply with one of the following:

- a) UL 60730-1 and UL 60730-2-7.
- b) The Electronic Circuits requirements in Section [25](#).

5.6 Cords, cables, and internal wiring

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

5.6.2 Flexible cords and cables shall comply with UL 62. Flexible cord and cables are considered to comply with this requirement when pre-assembled in a cord set or power supply cord that complies with UL 817.

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

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

- a) UL 44;
- b) UL 83;
- c) UL 66;
- d) *The appropriate UL standard(s) for other insulated conductor types specified in Wiring Methods and Materials, Chapter 3 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 is not required to comply with UL 758.

5.7 Ground-fault, arc-fault, and leakage current detectors/interrupters

5.7.1 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."

5.7.2 Appliance-leakage-current interrupters (ALCI) for protection against electrical shock shall comply with UL 943B.

5.7.3 Arc-fault circuit-interrupters (AFCI) shall comply with UL 1699.

5.8 Heaters, heating elements and pads

5.8.1 Electric resistance heating elements shall comply with the construction requirements in one of the following:

- a) UL 499;
- b) UL 1030.

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

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

5.9 Insulation systems

5.9.1 Materials used in a Class 105 (A) insulation system shall comply with Insulating Material, Section [15](#).

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

5.10 Light sources and associated components

5.10.1 Lampholders and indicating lamps shall comply with UL 496.

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

5.10.2 Lighting ballasts shall comply with one of the following:

- a) UL 935;
- b) 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).

5.10.3 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 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 end product standard.

5.11 Overcurrent protection

5.11.1 Fuses shall comply with 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.

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

5.11.3 Circuit breakers shall comply with UL 489.

Exception: Circuit breakers used in telecommunications circuitry that comply with UL 489A, is not required to comply with UL 489.

5.11.4 Circuit breakers having integral ground fault circuit interrupter capability for protection against electrical shock shall additionally comply with UL 943.

5.11.5 Supplementary protectors shall comply with UL 1077.

5.12 Power supplies

5.12.1 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"; or
- c) UL 62368-1, marked "Class 2" that complies with the limited power source (LPS) requirements and is marked "LPS".

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

- a) UL 1012;
- b) UL 60950-1; or
- c) UL 62368-1.

5.13 Printed wiring boards

5.13.1 Printed wiring boards shall comply with UL 796. A printed wiring board shall have a temperature rating corresponding to the maximum temperature on the board during the Temperature Test. Unless wholly in a Class 2 circuit, it shall comply with the direct support of live parts requirements in UL 796.

5.14 Quick-connect wire connectors

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

5.14.2 Quick-connect type wire connectors shall comply with UL 310.

5.15 Semiconductors and small electronic components

5.15.1 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with UL 1557. It shall have been evaluated for a minimum 1500 volts isolation.

5.15.2 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. It shall have been evaluated for a minimum 1500 volts isolation.

5.15.3 Except as specified in [5.15.4](#), 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.

5.15.4 Where an electronic component is determined to be a critical component during the Abnormal Operation Test, Section [54](#), one of the following standards shall be applied. See [24.4](#) of this end product standard for the test parameters to be used.

- a) UL 991, including its Follow-Up Program; and as applicable, UL 1998 for controls that rely upon software as a protective component; or
- b) UL 60730-1.

5.15.5 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.

5.15.6 A critical component may also be identified using a failure-mode and effect analysis (FMEA) in accordance with Failure-Mode and Effect Analysis (FMEA) requirements in UL 991.

5.16 Supplemental insulation, insulating bushings, and assembly aids

5.16.1 The requirements for supplemental insulation (e.g. tape, sleeving, or tubing) are not specified unless the insulation or device is required to comply with the requirements in Insulating Material, Section [15](#), or a performance requirement of this end product standard. In such cases:

- a) UL 510;
- b) UL 1441;
- c) UL 224.

5.16.2 Wire positioning devices shall comply with the requirements in Insulating Materials, Sections [15](#) and Separation of Circuits, Section [17](#). A device that complies with UL 1565, is considered to fulfill this requirement.

5.16.3 Insulating bushings that comply with the requirements in General, Section [5.1](#) of this end product standard, and UL 635, are considered to fulfill the requirements of this end product standard. Tests specified in this end product 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.

5.17 Switches

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

- a) UL 61058-1;
- b) UL 20;
- c) 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) is not required to comply with this requirement.

5.17.2 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) UL 60730-1 and UL 60730-2-7.

b) The Electronic Circuits requirements in Section [25](#).

5.17.3 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 6000 cycles of operation, or as a manual control for 1000 cycles of operation, in accordance with one of the following:

a) UL 60730-1 and UL 60730-2-7.

b) The Electronic Circuits requirements in Section [25](#).

5.17.4 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 [5.5.7](#).

5.17.5 Switches that comply with UL 61058-1, shall be rated as specified in [5.17.6](#) – [5.17.8](#).

5.17.6 Power switches shall be rated as follows:

a) For a voltage not less than the standard rated voltage of the circuit or power supply to which they are connected;

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

c) For Continuous Duty;

d) With respect to load:

1) Switches for motor-operated appliances: for resistance and motor load if the switch would encounter this load in normal use; or

2) Switches may be regarded as switches for a declared specific load and may be classified based upon the load conditions encountered in the appliance under normal load.

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

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

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

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

a) Power switches: 6000 cycles;

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

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

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

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

2) Switches for 20 mA load as classified in UL 61058-1.

5.18 Terminal blocks

5.18.1 Terminal blocks shall comply with one of the following:

- a) UL 1059;
- b) UL 60947-7-1;
- c) UL 60947-7-2;
- d) UL 60947-7-3.

5.18.2 The UL 60947-7 series of standards specified in [5.18.1](#) (b) – (d) are used in conjunction with UL 60947-1.

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

5.19 Transformers

5.19.1 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.

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

5.20 Valves (electrically operated) and solenoids

5.20.1 Electrically operated valves shall comply with one of the following:

- a) UL 429;
- b) UL 60730-1 and UL 60730-2-8.

5.21 Wire connectors

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

5.21.2 Wire connectors shall comply with UL 486A-486B, or UL 486E.

5.21.3 Splicing wire connectors shall comply with UL 486C.

5.22 Thermistors

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

5.22.2 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 Safety Critical Functions

6.1 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.

6.2 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.

6.3 Functions specified in the table represent the common safety critical circuit functions of typical appliances under the scope of this standard. 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 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.

Table 6.1
Safety Critical Functions

Function	Hazard	Location of parameters and tests
Motor running overload protection	Risk of fire or electric shock	20.2
Motor locked rotor protection	Risk of fire or electric shock	20.2
Motor short circuit protection	Risk of fire or electric shock	20.2

7 Frame and Enclosure

7.1 General

7.1.1 Equipment shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it may be subjected, without increasing the risk of fire, electric shock, or injury to persons due to total or partial collapse resulting in a reduction of spacings, loosening or displacement of parts, or other defects.

7.1.2 Equipment that complies with the requirements in [7.1.3](#) – [7.7.1](#) is considered to comply with [7.1.1](#).

7.1.3 The enclosure shall prevent molten metal, burning insulation, flaming particles, or the like from falling on combustible materials, including the surface upon which the equipment is supported.

7.2 Barriers

7.2.1 The requirement in [7.1.3](#) will necessitate that a switch, a relay, a transformer, a solenoid, or the like be individually and completely enclosed, except for terminals, unless it can be shown that malfunction of the component would not result in a risk of fire, or there are no openings in the bottom of the appliance enclosure.