UL 244B

STANDARD FOR SAFETY

Field Installed and/or Field Connected Appliance Controls

UL Standard for Safety for Field Installed and/or Field Connected Appliance Controls, UL 244B

First Edition, Dated May 12, 2021

SUMMARY OF TOPICS

This revision of ANSI/UL 244B dated November 6, 2024 includes button/coin cell batteries; 4.3.4.

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated August 2, 2024.

No Text on This Page

MAY 12, 2021
(Title Page Reprinted: November 6, 2024)

ANSI/UL 244B-2024

UL 244B

Standard for Field Installed and/or Field Connected Appliance Controls

First Edition

May 12, 2021

This UL Standard for Safety consists of the First Edition including revisions through November 6, 2024.

The most recent designation of ANSI/UL 244B as an American National Standard (ANSI) occurred on November 6, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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.

No Text on This Page

CONTENTS

INTRODUCTION

CONSTRUCTION

PERFORMANCE

No Text on This Page

INTRODUCTION

1 Scope

1.1 These requirements cover electrical controls that are complete in construction and designed specifically for installation in North America. These products are intended to be installed within the guidelines and requirements of the National Electrical Code, NFPA 70 and other relevant building codes.

Note – Examples are cord-connected controls with standard NEMA plugs and receptacles, direct plug-in controls and controls intended to be mounted in wiring boxes.

1.2 This standard applies to sensing controls for non-industrial use. These controls may be remotely-actuated (near-field communications) and respond to motion, light, sound, infrared input signals (passive and active type), power line carrier signals, radio frequency input signals and similar stimuli. In combination with one or more of the aforementioned stimuli, these controls may also be time responsive.

Single stimuli sensing controls (for instance, photoelectric switches) are covered under the scope of UL 773A, the Standard for Photoelectric Switches. Multi-functional controls are covered under the scope of this standard provided that the product's primary function is not covered under another standard of safety.

1.3 This standard applies to controls that are located remote from the loads being controlled using near-field communication methods. If the output functions of the control are deemed safety-relevant and/or if there are internal protective circuits that are relied upon for the inherent safety of the control, then the circuits are investigated per the requirements of this standard.

1.4 This standard applies to controls having solid state circuitry (single device or interconnected series of components) that are complete in construction and designed with one or more I/O ports. Included are controls with one or more output switching components to directly or indirectly control all or a portion of non-industrial-type appliances, such as portable luminaires, audio/video equipment, pumps, including sump pumps, motors, etc. These controls typically respond directly or indirectly to sensors or remote actuated signals to affect operation or electronically store or process information by virtue of a memory system. This standard also applies to manual controls when such are electrically and/or mechanically integral with solid-state sensing controls.

1.5 Sensing controls for equipment not intended for normal household use, but which nevertheless may be used by the public, such as equipment intended to be used by laymen in shops, commercial installations and on farms, are within the scope of this standard.

1.6 For a control covered by this standard, it is assumed that:

a) No voltage greater than 600 V with reference to earth ground will be present in a control,

b) An isolation transformer, if provided, will generally furnish power at a lower potential than the primary voltage.

If conditions other than these are provided, consideration shall be given to the need for additional requirements.

1.7 A control covered by this standard is a single device or a series of separate modules with interconnecting wiring employing one or more input power ports and, possibly, one or more signal ports, solid-state circuitry, and one or more output switching components to directly control all of the loads. The maximum number of integrated controlled outlets on the control shall not exceed four and the maximum total current draw of the control under continuous duty shall not exceed 85 % of the branch circuit protection rating.

1.8 These requirements also cover controls intended for connection only to a low-voltage circuit of limited power supplied by a primary battery or by a Class 2 transformer.

1.9 These requirements do not cover a control intended for installation in appliances, refrigeration or air conditioning equipment or similar equipment. Such controls and those intended for the global market are covered by the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1, and/or the applicable Part 2 standard from the UL 60730 series.

1.10 Products that are intended to be used in conjunction with or part of a building automation control system are not covered under the scope of this standard. Such products are covered under the Standard for Automatic Electrical Controls – Part 1: General Requirements, UL 60730-1.

1.11 Products that serve as emergency shut-off devices for cooking equipment are covered under the scope of this standard and shall comply with the requirements of this standard. Additionally, such devices shall comply with the requirements related to the associated safety functions for emergency shut-off devices in supplement SB of UL 858 – safety of Electromechanical and electronic controls.

1.12 The following products are not covered under the scope of this standard:

a) This standard is not applicable to Controlled Receptacle – A wall-box mounted receptacle with integral switching means intended for energy management and building automation in accordance with Article 406.3 of the NEC and rated 15- and 20-ampere, 250 Volts or less. Controlled Receptacles are investigated in accordance with the Outline of Investigation for Receptacles with Integral Switching Means, UL 498B.

a) Controls that employ a dimming function as a primary function and are intended to be permanently installed in outlet boxes are covered under the Standard for Solid-State Dimming Controls, UL 1472.

c) Solid state fan speed controls provided with a power supply cord, those intended for permanent connection and direct plug-in devices are covered under the scope of the Standard for Solid-State Fan Speed Controls, UL 1917.

d) Controls of the light-sensitive or presence-sensitive types, or both; for indoor or outdoor service are covered under the scope of the Standard for Nonindustrial Photoelectric Switches for Lighting Control, UL 773A.

e) Clock-operated switches or timers that are either cord-connected or direct plug-in devices are covered under UL 60730-2-7, the standard for Timers and Time-switches.

2 Undated References

2.1 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 Glossary

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

3.1A APPLIANCE CONTROL, MODULAR ASSEMBLY – A device consisting of a separable terminal assembly and control.

3.2 CLASS 2 CIRCUIT – An isolated secondary circuit involving a potential of not more than 30 Vrms or 42.4 V peak or 60 Vdc supplied by:

a) An inherently-limited Class 2 transformer;

b) A combination of an isolated transformer secondary winding and a fixed impedance or regulating network that together comply with the performance requirements for an inherently-limited Class 2 transformer;

c) A dry-cell battery having output characteristics not greater than those of an inherently-limited Class 2 transformer;

d) Any combination of (a), (b), and (c) that together comply with the performance requirements for an inherently-limited Class 2 transformer; or

e) One or more combinations of a Class 2 transformer and an overcurrent protective device that together comply with the performance requirements for a non-inherently limited Class 2 transformer.

Note – A circuit derived from a line-connected circuit by connecting impedance in series with the supply circuit as a means of limiting the voltage and current is not a Class 2 circuit. See Class 2 Circuits, Section 21.

3.3 CONFORMAL COATING – An insulating coating which conforms to the configuration of the object coated and is used as a protective covering against environmental conditions or when electrical spacings are insufficient.

3.4 CONTROLLED ENVIRONMENT – An environment:

a) Relatively free of conductive contaminants, such as normal cooking vapors, carbon dust, and similar contaminants, due to the anticipated mounting or use location, and

b) Not subject to humidity and the formation of condensation. A controlled environment is provided, for example, by means of a:

1) Hermetically sealed enclosure;

2) Encapsulation;

3) A conformal coating; or

4) A gasketed, tight-fitting enclosure or filter system preventing contamination in conjunction with a system preventing condensation - for example, the maintaining of the surrounding air at constant temperature and a suitably low relative humidity.

3.5 DEAD-CASE-MOUNTED SEMICONDUCTOR – A semiconductor, such as a triac or silicon-controlled rectifier, employing an integral metal tab or stud that is insulated from live parts.

3.6 ELECTRICAL STRESS FACTOR – For a circuit component, the ratio of operating electrical stress to rated electrical stress. Examples include the ratio of operating wattage to maximum rated wattage of a resistor and operating voltage to maximum rated voltage of a capacitor. A circuit component having no assigned maximum operating electrical rating is made the subject of an investigation.

3.7 ENCLOSURE – The part of the device that:

a) Renders inaccessible all or any parts of the device that may present a risk of electric shock or injury to persons; and

b) Retards propagation of fire initiated from within the device

3.8 FIXED EQUIPMENT – Fastened in place equipment connected to a permanent wiring system, such as conduit, etc.

3.9 ISOLATED SECONDARY CIRCUIT – A circuit derived from an isolated secondary winding of a transformer and that has no direct connection back to the line-connected circuit, other than through the grounding means.

Note – A secondary circuit that has a direct connection back to the line-connected circuit is considered part of the line-connected circuit.

3.10 LIMITED-ENERGY CIRCUIT – A line-connected circuit in which the wattage from any point in the circuit to any return to the power supply is limited to 15 W; or an isolated secondary circuit in which the wattage from any point in the circuit to any return to the power supply is limited to 15 W.

3.11 LINE-CONNECTED CIRCUIT – A circuit in which the wiring and components are conductively connected to the branch circuit. It is also called a primary- or direct-connected circuit. See also 3.10.

3.12 LIVE PART – conductor or conductive part intended to be energized in normal use, including a neutral conductor.

3.13 OPPOSITE POLARITY – A difference in potential between two points, such that shorting of these two points results in a condition involving an overload; rupturing of printed wiring-board-tracks, components, or fuses; or similar condition.

3.14 OPTICAL ISOLATOR (PHOTON-COUPLED ISOLATOR) – A circuit-coupling device that provides circuit isolation by means of a light source and sensor integrated into a single package.

3.15 OUTLET – A female connector intended to accept an attachment plug of a direct plug-in or cord connected product. Similar to a receptacle; receptacles are provided on outlet box-mounted devices (NEC Section 406.3(E)); outlets are provided on non-outlet box-mounted style controls.

3.16 OUTLET-BOX DEVICE – A device intended to be installed into or on the non-enclosed side of an electrical box, with or without a cover plate.

3.17 PORTABLE EQUIPMENT – Cord and plug or direct plug-in connected equipment that is capable of being carried or readily moved about.

3.18 PRESSURE WIRE CONNECTOR TERMINAL – A wire connection/termination whereby the wire is inserted into a clamping mechanism, without forming, and is fastened in place, generally by screw or spring clamp action.

3.19 SAFETY CIRCUIT – A primary or secondary circuit that is relied upon to reduce the risk of fire, electric shock, injury to persons or operation of controlled equipment that is capable of resulting in a risk of fire, electric shock, or injury to persons.

Note – Examples include an interlock circuit, a circuit which limits leakage current to accessible parts, a circuit which limits the wattage to a limited-energy circuit, a phase control or other circuits designed to limit temperatures in the controlled load or serve as equipment safeguards.

3.19A SEPARABLE TERMINAL ASSEMBLY – A two-piece terminal provided with an integral mechanical latching mechanism(s). May be either installed (i.e. via a special purpose connector) into a device box or secured (i.e. via a back-plate) to the device box. Provided with either insulated conductors or wiring terminals for connection to the branch circuit conductors.

3.20 SNAP-ON COVER – A cover that is held in place by friction-fit and not requiring the operation of a tool-operated fastener for removal.

3.21 STATIONARY EQUIPMENT – Cord and plug connected equipment that is intended to be fastened in place, or located in a dedicated space because of its size or weight, such as a refrigerator, electric washing machine, etc.

3.22 TRANSFORMER – The term includes a motor-transformer or an autotransformer. For the purpose of these requirements, the types of transformers typically encountered in or supplying power to controls are:

a) Class 2 – An isolation type transformer as specified in the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1, and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

b) Power – A transformer other than Class 2 that is intended to transmit power. Included are isolation and non-isolation (such as an autotransformer) types.

c) Pulse – An isolation-type transformer designed to pass pulse waveforms as distinguished from sine waves. It is not considered to be a power transformer.

d) Current Sensing – An isolation-type transformer designed to have the primary winding connected in series with a circuit carrying current to be measured or controlled. In “window-type” current transformers, the primary winding is provided by a separate conductor and is not an integral part of the transformer.

e) Isolating – A transformer in which one or more secondary windings are electrically separated by insulation, spacings, or both, from the primary windings. Secondary windings are not required to be electrically separated from other secondary windings.

3.23 WIRE BINDING SCREW TERMINAL – A wire connection/termination whereby the wire is intended to be secured directly beneath the screwhead after being formed into a 3/4 loop hook.

4 Components

4.1 General

4.1.1 Except as indicated in 4.1.2, a component of a product covered by this standard shall comply with the requirements for that component. See Annex A for a list of standards covering components generally used in the products covered by this standard.

4.1.2 A component is not required to comply with a specific requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

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

4.1.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

4.2 Attachment plugs, receptacles, connectors, and terminals

4.2.1 Attachment plugs and receptacles shall comply with the requirements of Standard for Attachment Plugs and Receptacles, UL 498. See also the Single Pole Insertion test of Section 40.

4.2.2 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 in), intended for internal wiring connections in appliances, shall comply with the Standard for Electrical Quick-Connect Terminals, UL 310.

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

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

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

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

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

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

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

4.2.9 Female devices (such as receptacles/outlets and connectors) that are intended for current interruption of the specific type of load, shall be suitably rated 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.

4.2.10 Bonding devices, ground clamps, grounding and bonding bushings and locknuts, and similar equipment, shall comply with the Standard for Grounding and Bonding Equipment, UL 467.

4.3 Batteries

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

4.3.2 Rechargeable nickel cadmium (Ni-Cad) cells and battery packs shall comply with the performance requirements of this standard.

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

4.3.4 The battery compartment of a control or any accessory, such as a wireless control, incorporating one or more button batteries or coin cell batteries shall comply with the Standard for Products Incorporating Button Batteries or Coin Cell Batteries, UL 4200A, if the control or any accessory:

a) Is intended for use with one or more single cell batteries having a diameter of 32 mm (1.25 in) maximum with a diameter greater than its height; and

b) The control is intended for household use.

4.4 Electrical boxes and raceways

4.4.1 Electrical boxes and the associated bushings and fittings, and raceways, of the types specified in Chapter 3 of the National Electrical Code, NFPA 70 and that comply with one of the following standards:

a) Standard for Metallic Outlet Boxes, UL 514A,

b) Standard for Conduit, Tubing, and Cable Fittings, UL 514B,

c) Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C, or

d) Standard for Cover Plates for Flush-Mounted Wiring Devices, UL 514D.

4.5 Capacitors

4.5.1 A capacitor shall employ materials and be constructed so that the capacitor will not constitute a risk of fire. Compliance shall be in accordance with 4.5.2 – 4.5.7.

4.5.2 A paper capacitor shall be impregnated or enclosed to exclude moisture.

4.5.3 A liquid-electrolyte, metalized-film or conductive-foil type electrolytic capacitor connected in a circuit capable of delivering a power greater than 15 W as determined in the Limited Power Point Determination Test, Section 27, and having a diameter of more than 0.394 in (10 mm), shall be provided with a means for relieving excessive internal pressure.

4.5.4 A capacitor connected between two line conductors in a primary circuit, or between one line conductor and the neutral conductor or between primary and accessible secondary circuits or between the primary circuit and protective earth (equipment grounding conductor connection) shall comply with one of the subclasses of the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14, and shall be used in accordance with its rating. Details for damp heat, steady state test can be found in 4.12 of UL 60384-14, Second Edition.

4.5.5 For a capacitor connected between primary and accessible secondary circuits, compliance with 4.5.4 shall be achieved by:

a) One (or more) adequately rated Class Y1 capacitor, or

b) Two (or more) adequately rated Class Y2 capacitors connected in series.

4.5.6 For a capacitor connected between primary and grounded parts complying with the requirements of Section 20, compliance with 4.5.4 shall be achieved by:

a) One (or more) adequately rated Class Y1 capacitor, or

b) One (or more) adequately rated Class Y2 capacitors.

4.5.7 For a capacitor connected between primary parts, compliance with 4.5.4 shall be achieved by:

a) One (or more) adequately rated Class X1 capacitor, or

b) One (or more) adequately rated Class X2 capacitors.

4.6 Filters

4.6.1 Electromagnetic interference filters with integral enclosures shall comply with the Standard for Electromagnetic Interference Filters, UL 1283.

4.7 Surge protective devices

4.7.1 Surge Protective Devices (SPDs), including air gaps and metal oxide varistors (MOVs), shall comply with the requirements in the Standard for Surge Protective Devices, UL 1449. As noted below,4.7.2 – 4.7.5, are applicable. Referenced ratings are per the Standard for Surge Protective Devices, UL 1449.

Exception: These requirements do not apply to SPDs located in a Class 2, <15 W circuit.

4.7.2 Type 1, 2, or 3 SPDs shall:

a) Maintain a Maximum Continuous Operating Voltage (MCOV) rating equal to or greater than working voltage of the circuit connected, and

b) Maintain the appropriate Type Rating for the application in accordance with Table 4.1

Table 4.1
Type 1, 2, or 3 Ratings

Application	Type Rating
Line side of service equipment	1
Load side of service equipment or feeder circuit applications	1 or 2
Branch circuit or control circuit applications	1 or 2 or 3

4.7.3 Type 4 or Type 5 discrete component SPDs and Type 4 component assemblies shall have a Maximum Continuous Operating Voltage (MCOV) rating equal to or greater than working voltage of the circuit connected.

4.7.4 Type 4 or 5 discrete component SPDs and Type 4 Component Assemblies shall be rated in accordance with (a) or (b):

a) A Type 4 discrete component SPD shall have an Operating Duty Cycle Voltage (V_p) and Peak Current (A_p) in accordance with Table 4.2, based on the working voltage of the circuit connected, or

Exception: For SPDs used in other than across-the-line applications such as in a non-isolated electronic circuit, the additional circuit impedance in series with the SPD can be considered when determining the required SPD ratings. The A_p rating of the SPD may be less than that defined in Table 4.2 provided the A_p rating is equal to or is greater than the surge current parameters

determine by a calculation that accounts for fixed series impedance inherent in the circuit. [The calculated A_p would be equal to V_p divided by the combined known impedance inherent in the circuit plus 2 ohms, which is the anticipated source impedance].

b) A Type 5 discrete component SPD or Type 4 component assemblies shall be rated with a Nominal Discharge Current, NDC (I_n) in accordance with Table 4.2, based on the working voltage of the circuit connected.

Exception: For SPDs used in other than across-the-line applications such as in a non-isolated electronic circuit, the additional circuit impedance in series with the SPD can be considered when determining the required SPD ratings. The I_n of the SPD may be less than that defined in Table 4.2 provided the I_n rating is equal to or is greater than the surge current parameters determine by a calculation that accounts for fixed series impedance inherent in the circuit. [The calculated In would be equal to V_p divided by the combined known impedance inherent in the circuit plus 2 ohms, which is the anticipated source impedance].

Table 4.2
Type 4 or 5 SPD Ratings

SPD circuit Phase-to-ground voltage, Vac[a] by overvoltage category[b]				Ratings of Type 4 or 5 SPDs
				Operating Duty Cycle Peak Current or Minimum Nominal Discharge Current, NDC (I_n) A
I	II	III	IV	
50	–	–	–	165
100	50	–	–	250
150	100	50	–	400
300	150	100	50	750
600	300	150	100	1250
–	600	300	150	2000
–	–	600	300	3000

[a] For ungrounded systems or systems with one phase grounded, the phase-to-ground voltage is considered to be the same as the phase-to-phase voltage for the purposes of using this table.

[b] Typical examples of categories for products are given below.

Category IV – Primary Supply Circuit Level. Overhead lines and cable systems including distribution and its associated overcurrent protective equipment (equipment installed at the service entrance).

Category III – Distribution Circuit Level. Fixed wiring and associated equipment (not electrical loads) connected to the primary supply level, Category IV.

Category II – Load Circuit Level. Appliances and portable equipment and the like connected to the distribution level, Category III.

Category I – Signal Circuit Level. Special equipment or parts of equipment such as low-voltage electronic logic systems, remote controls, signaling and power limited (per NEC Article 725) circuits connected to the load level, Category II.

4.7.5 SPDs are not permitted to be used between line / mains / non-Class 2 circuits and Class 2 circuits.

4.8 Thermistors and thermal links

4.8.1 A temperature sensing positive temperature coefficient (PTC) or negative temperature coefficient (NTC) thermistor shall comply with the Standard for Thermistor-Type Devices, UL 1434.

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

4.9 Cords and cables

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

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

4.10 Gaskets and seals

4.10.1 Gaskets and seals that is relied upon to prevent the ingress of water and/or dust shall comply with the performance requirements of the Standard for Gaskets and Seals, UL 157.

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

4.11.1 Ground-fault circuit-interrupters (GFCI) for protection against electrical shock shall comply with the Standard for Ground-Fault Circuit-Interrupters, UL 943, including any end-use equipment marking or instruction manual statement requirements.

4.11.2 Appliance-leakage-current interrupters (ALCI) for protection against electrical shock shall comply with the Standard for Appliance-Leakage-Current Interrupters, UL 943B. An ALCI is not considered an acceptable substitute for a GFCI when a GFCI is required by the National Electrical Code, NFPA 70.

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

4.11.4 Arc-fault circuit-interrupters (AFCI) shall comply with the Standard for Arc-Fault Circuit-Interrupters, UL 1699.

4.11.5 Leakage-current detector-interrupters (LCDI) and any shielded cord between the LCDI and appliance shall comply with Standard for Arc-Fault Circuit-Interrupters, UL 1699.

4.12 Insulation systems

4.12.1 Materials used in an insulation system that operates above Class 105 (A) temperatures shall comply with the Standard for Systems of Insulating Materials – General, UL 1446 or the Standard for Single- and Multi-Layer Insulated Winding Wire, UL 2353.

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

4.13 Light sources and associated components

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

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

4.14 Marking and labeling systems

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

4.15 Overcurrent protection

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

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

Exception: Circuit breakers used in telecommunications circuitry that comply with the Standard for Circuit Breakers For Use in Communications Equipment, UL 489A, need not comply with the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489.

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

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

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

4.16 Power supplies

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

a) The Standard for Class 2 Power Units, UL 1310;

b) The Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, with an output marked “Class 2”, or that complies with the limited power source (LPS) requirements and is marked “LPS”; or

c) The Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1 with an output marked “Class 2”, or that complies with the limited power source (LPS) requirements and is marked “LPS”; or

d) Integral Switch Mode Power Supplies investigated in accordance with Section 21 and Section 29 of this Standard.

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

a) The Standard for Power Units Other Than Class 2, UL 1012; or

b) The Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or

c) The Standard for Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1, or

d) Integral Switch Mode Power Supplies investigated in accordance Section 29 of this Standard.

4.17 Printed wiring boards

4.17.1 A printed-wiring board, including the coatings, shall comply with the requirements in the Standard for Printed Wiring Boards, UL 796. A printed-wiring board containing circuitry in a line-connected circuit shall comply with the direct-support requirements in UL 796. Conformal coatings shall comply with the requirements in the standard for Polymeric Materials – Industrial Laminates, Filament wound tubing, Vulcanized Fibre, and Materials used in printed wiring boards, UL 746E.

Exception: A printed-wiring board in a Class 2 non-safety circuit is not required to comply with the bonding requirements in the Standard for Printed Wiring Boards, UL 796 if 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.

4.17.2 A printed-wiring board, including the coating, shall have a minimum flammability classification of V-2 as specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception: A printed-wiring board, including the coating, in a Class 2 circuit or an isolated secondary limited-energy circuit shall have a minimum flammability classification of HB as specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

4.18 Power switching semiconductors and optical isolators

4.18.1 A power switching semiconductor device that is relied upon to provide isolation to ground shall comply with the Standard of Safety for Electrically Isolated Semiconductor Devices, UL 1557. The dielectric voltage withstand tests required by UL 1557 shall be conducted applying the criteria of Section 34 of this Standard.

Exception: This requirement does not apply if the semiconductor is intended to be secured to an inaccessible metal part physically isolated, electrically insulated, or both from other live parts or accessible dead metal parts.

4.18.2 An optical isolator that is relied upon to provide isolation between primary and secondary circuits or between other circuits as required by this end product standard shall comply with the Standard for Safety for Optical Isolators, UL 1577. The dielectric voltage withstand tests required by UL 1577 shall be conducted applying the criteria of Section 34 of this Standard.

4.19 Supplemental insulation, insulating bushings, and assembly aids

4.19.1 The requirements for supplemental insulation (e.g. tape, sleeving or tubing) shall comply with the following:

a) Insulating tape shall comply with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510;

b) Sleeving shall comply with the Standard for Coated Electrical Sleeving, UL 1441;

c) Tubing shall comply with the Standard for Extruded Insulating Tubing, UL 224.

4.19.2 Wire positioning devices shall comply with Section 13, Insulating Materials, and Section 12, Separation of Circuits. A device that complies with the Standard for Positioning Devices, UL 1565, is considered to comply with this requirement.