UL 8750

STANDARD FOR SAFETY

Light Emitting Diode (LED) Equipment for Use in Lighting Products

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

Second Edition, Dated September 15, 2015

Summary of Topics

This revision to ANSI/UL 8750 dated December 7, 2022 was issued to incorporate the following changes in requirements:

- ***Scope Update to Include Power Sources; 1.1, 3.13, 3.21 – 3.23, 8.1.3, 8.2.2 and 8.7.3.1***
- ***Adding UL 62368-1 to 4.1 List of Standards***
- ***Requirements for Coin Cell Lithium Batteries; 6.1.7***
- ***Correction for Dimensional Requirements in Exception No. 3 of 6.4.1***
- ***Clarification for Grounding and Bonding; 7.2A.1.4***
- ***Supply Connection Options for Built-in Products; 7.4.1.4***
- ***Correct cross reference in 7.11.2.4(b)***
- ***Dielectric Voltage Withstand Testing for Products with Integral SPDs; 8.6.1***
- ***Specifications for Cheesecloth in 8.7.1.1(d)***
- ***Updates to Marking Requirements; 3.2.1, 3.7.3, 9.1.4 – 9.1.8, 9.2.2, 9.2.4, 9.2.5, Section 9.2A, 9.3.1, 9.3.7 – 9.3.9, Section SB4, SC5.1, SC5.2, SC5.5, SD9.2 – SD9.4, Figure SD9.1, SE5.3, SF8.3, SF8.5, SF8.6, SG5.2, Section SH4, SI6.1, Section SJ7 and Appendix C***
- ***Clarification for SA3.3***
- ***Control Circuit Lead Wire Colors; SF4.2***

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

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated September 16, 2022.

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UL 8750

Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products

First Edition – November, 2009

Second Edition

September 15, 2015

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through December 7, 2022.

The most recent designation of ANSI/UL 8750 as an American National Standard (ANSI) occurred on December 7, 2022. 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 UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover LED equipment that is an integral part of LED luminaires or lighting systems. These requirements cover LED drivers, controllers, arrays (modules), and packages as defined within this standard. These requirements also cover power sources that are integrated into LED luminaires or lighting systems for functions other than a LED driver (e.g., DALI bus power supply).

1.1.0 LED equipment covered by this standard are intended for operation in the visible light spectrum between 400 – 700 nm. Coherent light sources (e.g. laser sources) are not covered by this standard.

Exception No. 1: LED packages as described in Supplement SD may have applications other than general illumination and may operate outside of the visible light spectrum.

Exception No. 2: Special Use LED arrays as described in Supplement SJ have intended applications other than general illumination and may operate outside of the visible light spectrum.

1.1.1 *Deleted*

1.1.2 *Deleted*

1.1.3 These requirements do not cover LED controllers within the scopes of the following standards:

a) Standard for Safety for Plug-In Locking Type Photocontrols for Use with Area Lighting, UL 773, or

b) Standard for Safety for Solid-State Dimming Controls, UL 1472.

1.2 These lighting products are intended for installation on branch circuits of 600 V nominal or less in accordance with the National Electrical Code (NEC), ANSI/NFPA 70, and for connection to isolated (non-utility connected) power sources such as generators, batteries, fuel cells, solar cells, and the like.

1.3 LED equipment is utilized in lighting products that comply with the end-product standards listed below. The requirements in this standard are intended to supplement those in other end-product standards. Included are:

a) Electric Signs, UL 48,

b) Portable Electric Luminaires, UL 153,

c) Underwater Luminaires and Submersible Junction Boxes, UL 676,

d) Emergency Lighting and Power Equipment, UL 924,

e) Stage and Studio Luminaires and Connector Strips, UL 1573,

f) Track Lighting Systems, UL 1574,

g) Luminaires, UL 1598,

h) Direct Plug-In Nightlights, UL 1786,

i) Low Voltage Landscape Lighting Systems, UL 1838,

j) Self-Ballasted Lamps and Lamp Adapters, UL 1993,

k) Luminous Egress Path Marking Systems, UL 1994, and

l) Low Voltage Lighting Systems, UL 2108.

1.4 The requirements in this standard do not anticipate additional construction, performance and marking considerations for the following end-applications: LED equipment subject to weather (outdoor use), LED equipment installed in air handling spaces or in other environmental air spaces (plenums), LED equipment intended for Emergency Lighting and Power Equipment, LED equipment with integral batteries (and battery packs), and LED equipment used in fire rated installations. LED equipment with such end-applications is subject to additional evaluation per applicable standards.

2 General

2.1 Components

2.1.1 Except as indicated in this clause, a component of a product covered by this standard shall comply with the requirements for that component. See the Standards for Components appendix for a list of standards covering components generally used in the products covered by this standard.

2.1.2 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.

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

2.1.4 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.

2.2 Units of measurement

2.2.1 Except for conductor size, values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

2.2.2 All values of voltage and current are true root mean square (rms) values unless otherwise indicated.

2.2.3 For customary purposes wire sizes are in American Wire Gauge (AWG).

2.3 Reference publications

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

3 Definitions

3.1 For the purpose of these requirements, the following definitions apply.

3.2 BARRIER – A part of the unit intended to physically limit access to parts that pose a risk of electric shock.

3.2.1 BUILT-IN PRODUCT – A component or subassembly that is intended for installation within an enclosure. See 3.4.1.

3.3 CIRCUIT, CLASS 2 – A circuit supplied by an isolating source that complies with the requirements of the Standard for Class 2 Power Units, UL 1310, or the Class 2 requirements of the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

3.4 CIRCUIT, ISOLATED LOW VOLTAGE LIMITED ENERGY (LVLE) – A circuit supplied by an isolating source (i.e. no direct electrical connection between input and output, such as provided by a transformer or optical isolator), and with output parameters as noted in 8.16.1.

Note – Throughout this standard LVLE circuits are afforded the same exemptions for risks of fire and electric shock as with Class 2 circuits. However, end-product lighting standards may have additional provisions for LVLE circuits. For example, UL 1598 (Luminaires) does not provide for a risk of fire exemption when the LVLE circuit is not contained within the luminaire.

3.4.0 DIRECT PLUG-IN LED DRIVER – A unit which employs a blade assembly on the enclosure for connection to the branch circuit. Output supply is typically provided via a cable terminating in a connector.

3.4.1 ENCLOSURE – A housing of a unit that is intended to prevent contact with uninsulated parts that represent a risk of electric shock (electrical enclosure), contain any fire initiated within the unit (fire enclosure), and prevent mechanical damage to internal parts.

3.5 ENCLOSURE, ELECTRICAL – A part of the equipment intended to limit access to parts operating at voltage levels that represent a risk of electric shock per 3.24.

3.6 ENCLOSURE, FIRE – A part of the equipment that encloses circuits that are considered a risk of fire per 3.25.

3.6.1 ENCLOSURES INTENDED FOR CONDUIT CONNECTION – An enclosure with facility for connection to branch circuit via conduit. In this standard this type of enclosure is utilized for remote LED drivers and for LED drivers that are secured to an exterior surface of a luminaire enclosure. The LED driver output may also be connected via conduit. When installed as intended, unused conduit knockouts and other openings are covered so the electrical and fire enclosure requirements of the standard are fulfilled.

3.7 ENVIRONMENTAL LOCATIONS

a) DRY LOCATION – A location not normally subject to dampness, but may include a location subject to temporary dampness, as in the case of a building under construction, provided ventilation is adequate to prevent an accumulation of moisture.

b) DAMP LOCATION – An exterior or interior location that is normally or periodically subject to condensation of moisture in, on, or adjacent to, electrical equipment, and includes partially protected locations.

c) WET LOCATION – A location in which water can drip, splash, or flow on or against electrical equipment.

3.7.1 FEEDTHROUGH CIRCUIT – Circuitry integral to LED equipment designed to pass its input power source to other utilization equipment- often another LED equipment of the same design- from the same source of supply without conditioning. In this standard feedthrough circuits are treated as output circuits with the same supply characteristics as the input supply.

3.7.2 FEEDTHROUGH RECEPTACLE – A feedthrough circuit in through cord LED drivers terminating in an integral receptacle, where the receptacle may be suitable for 1) a NEMA plug, 2) a mating connector, or

3) an appliance coupler. For through-cord LED drivers, the feedthrough may be provided in a length of supply cord terminating in the receptacle.

3.7.3 INSTRUCTION SHEET – A generic term for information that is provided with the product in printed form (e.g. an insert, or a booklet). Required product markings may be provided in an instruction sheet, where so permitted by this standard. The manufacturer may include other materials – unrelated to the marking requirements of this standard – in the instruction sheet. Also see 9.2A.

3.8 INSULATION-PIERCING TERMINAL – A terminal having a contact pin that punctures the conductor insulation and penetrates between the conductor strands.

3.9 ISOLATED CIRCUIT – A circuit with only magnetic, capacitive, or optical connection to any ground-referenced supply source. A low voltage circuit derived by a dropping resistor is not isolated.

3.10 LED (LIGHT EMITTING DIODE) – A solid-state component embodying a p-n junction, emitting optical radiation when excited by an electric current.

3.11 LED ARRAY (LED MODULE) – An assembly of one or more LED discrete electronic components on a printed circuit board, typically with optics and additional thermal, mechanical, and electrical interfaces.

3.12 LED CONTROLLER – A device or electronic circuitry that is designed to control light output characteristics, control/manage electrical supply to one or more luminaires, or sense and transmit luminaire operational performance and building environmental data. Control may be via signals transmitted through wired circuits (see Supplement SF) or via wireless signals.

3.13 LED DRIVER – A power source that adjusts the voltage or current to LED loads, ranging in complexity from a resistor to a constant voltage or constant current power supply. Also referred to as Lamp Control Gear.

3.13.1 LED LIGHTING SYSTEM – A network of LED lighting elements (luminaires, controllers, drivers, etc.) that are interconnected (through wired and wireless signaling) to manage operation of the equipment. Lighting system elements may be physically integrated together into one assembly or they may be remotely located from each other. Lighting system elements may be powered from a single source of supply or they may be separately supplied.

Note: The scope of this standard does not cover LED lighting systems. The definition provides clarity about potential applications for LED equipment that are in scope of this standard, see 1.1, as part of the system.

3.14 LED PACKAGE – An assembly of one or more LED die that contains wire bond connections and may include an optical element and thermal, mechanical, and electrical interfaces. The package does not include a power source and is not connected directly to the branch circuit.

3.15 MEASUREMENT INDICATION UNIT (MIU) – The rms equivalent value of a 60 Hz sinusoidal leakage current in milliamps (mA), adjusted to compensate as necessary for leakage currents composed of complex waveforms or frequencies other than 50 or 60 Hz. It is determined by dividing the output voltage (V3) in millivolts (mV) rms by 500 (the value in ohms of the resistance in parallel with V2) in the measurement instrument circuit in Figure 8.6.

3.16 PART, DEAD CONDUCTIVE – A conductive part that, under normal operating conditions, carries no electrical current other than leakage current.

3.17 PART, HAZARDOUS LIVE – A part located in a circuit that is operating in excess of the risk of electric shock or risk of fire limits.

3.18 PART, LIVE – A conductive part that has an electrical difference of potential with respect to earth ground or any other conductive part. A part connected to a grounded supply (neutral) conductor is considered to be a live part.

3.19 PLC (PERFORMANCE LEVEL CHARACTERISTIC) VALUE – An integer that defines a range of test values for a given electrical/mechanical property test for polymeric (plastic) materials as defined in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

3.19.1 POTTING – A process of filling the case of an electrical/ electronic assembly with material that may provide electrical insulation, environmental protection, heat transfer, vibration reduction, etc.

3.19.2 POTTING COMPOUND – Asphalt or Polymeric materials used to fill an electrical/ electronic assembly.

a) ASPHALT POTTING COMPOUND – Bituminous materials that are heated to flow, poured into an electronic assembly case and allowed to cool into a semi-solid. These materials are generally made from refined petroleum-based products mixed-in with inorganic materials (e.g. quartz, sand, etc.).

b) POLYMERIC POTTING COMPOUND – Plastics based materials that are typically poured, in liquid form, into an electronic assembly case and cured/ hardened in-place. These materials can be thermosetting or thermoplastic.

3.20 POWER LIMITED CIRCUIT – See Section 725 of the National Electrical Code (NEC), ANSI/NFPA 70.

3.21 POWER SOURCE, CLASS 2 – A power supply or transformer that complies with the requirements of the Standard for Class 2 Power Units, UL 1310, or the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3 respectively.

3.22 POWER SOURCE, ISOLATED LOW VOLTAGE LIMITED ENERGY (LVLE) – A power supply or transformer as defined by 3.4.

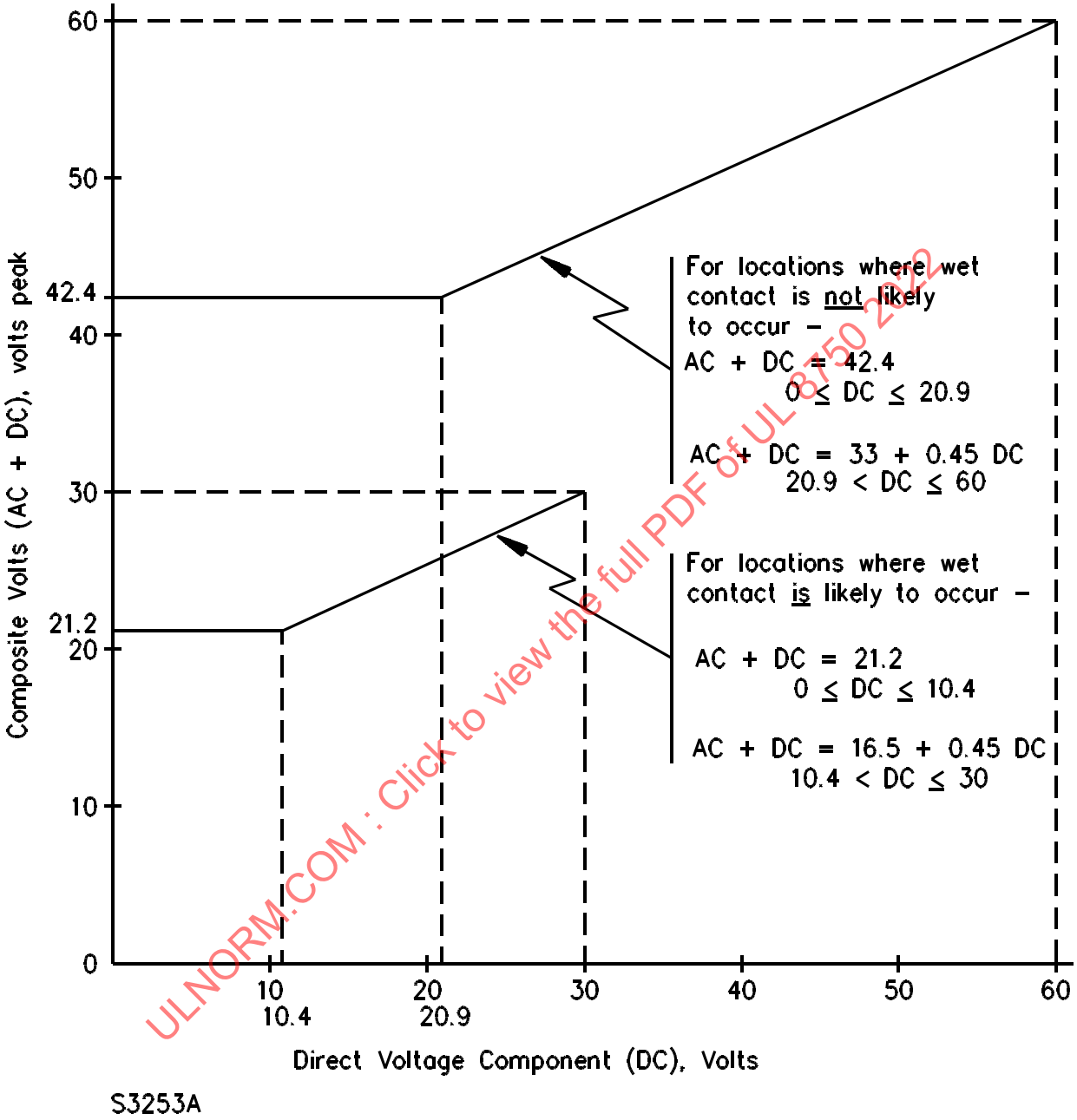
3.23 POWER SOURCE – An electronic device, assembled from components that collectively control its output current, voltage, or power within its design limits.

3.24 RISK OF ELECTRIC SHOCK – A risk of electric shock exists between any two conductive parts or between a conductive part and earth ground if the continuous current flow between the two points exceeds the leakage current limits determined by the Leakage Current Measurement Test, Section 8.9, and if the open circuit voltage exceeds the following limits:

	Maximum Voltage	
Waveform Type[a]	**Dry and Damp Locations**	**Wet Locations**
Sinusoidal ac	30 V rms	15 V rms
Non-sinusoidal ac	42.4 V peak	21.2 V peak
dc[b, c]	60 V	30 V
[a] The voltage limits for a composite AC + DC waveform (V peak) shall be per Figure 3.1 based on the Direct Voltage component (V DC) of the waveform. The graph line for locations where wet contact is not likely to occur refers to Dry and Damp locations. The graph line for locations where wet contact is likely to occur refers to wet locations.		
[b] If the peak-to-peak ripple voltage on a dc waveform exceeds 10 percent of the dc voltage, the waveform shall be considered a composite waveform per footnote a above.		
[c] DC waveforms interrupted at frequencies between 10 – 200 Hz shall be limited to 24.8 V in dry and damp locations, and 12.4 V in wet locations.		

Figure 3.1

Maximum voltage



3.25 RISK OF FIRE – A risk of fire exists in all electrical circuits except:

a) A Class 2 circuit,

b) An LVLE circuit, or

c) A circuit of 15 W maximum power limit under normal and single fault conditions, as measured in accordance with 8.8.

3.26 SECONDARY OPTIC – An optically transparent or translucent structure that is mechanically separate from the one or more LED packages it encloses. A secondary optic is generally intended to enhance performance by directing light paths and/or through the use of phosphors that shift the optical spectrum. In some cases, a secondary optic can serve as a fire enclosure, an electrical enclosure, an environmental barrier, and/or a UV emissions filter.

3.27 *Deleted*

3.27.1 THROUGH CORD LED DRIVERS – A unit which employs a cord and plug assembly for connection to the branch circuit. Output supply is typically provided via a cable terminating in a connector. Through cord LED drivers are not considered built-in products.

3.28 UNIT – A generic term meaning any discrete device, subassembly, or assembly.

3.29 UNIT, FIXED – A unit intended to be permanently connected electrically to the wiring system.

3.30 UNIT, PORTABLE – A unit that is easily carried or conveyed by hand, and is provided with a power-supply cord for connection to the supply circuit.

3.31 UNIT, STATIONARY – A unit that is intended to be fastened in place or located in a dedicated space, and is provided with a power-supply cord for connection to the supply circuit.

4 Power supplies, LED Drivers, and Transformers

4.1 A power supply or LED driver shall comply with the requirements of this standard. Compliance with the requirements of one or more of the following standards shall be considered to meet the intent of any equivalent requirements within this standard:

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,

c) The Standard for Power Units Other Than Class 2, UL 1012,

d) The Standard for Fluorescent-Lamp Ballasts, UL 935, or

e) The Standard for Audio/Video, Information and Communication Technology Equipment – Part 1, UL 62368-1.

4.2 A transformer for use with LED units that complies with any one of the following standards is considered to meet the intent of the requirements of this standard:

a) 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) The Standard for Transformers and Motor Transformers for Use in Audio-, Radio- and Television-Type Appliances, UL 1411,

c) The Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2, or

d) The Standard for Dry-Type General Purpose and Power Transformers, UL 1561.

4.3 A power supply, LED driver, or transformer shall be used within its rated input, output, and environmental ratings.

CONSTRUCTION

5 Environmental Considerations

5.1 A unit intended for dry locations only shall be so identified and shall not be provided with any information such as markings, instructions, or illustrations that implies or depicts damp or wet use.

5.2 A unit intended for damp locations shall be:

a) Subjected to the environmental tests of 8.14 unless all live parts and traces on the printed wiring board are potted (see 6.7) or conformal coated (see 7.7.6),

b) If provided with a polymeric enclosure, comply with the Resistance to Impact test of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, using a preconditioning temperature of 0 ±2.0°C (32 ±3.6°F), and

c) Eligible to be marked as suitable for damp locations, and not be provided with any information such as markings, instructions, or illustrations that implies or depicts wet use.

Exception: A circuit operating at Class 2 or LVLE power levels in which voltage levels are below those that present a risk of electric shock per 3.24 is not required to be subjected to parts (a) and (b) above.

5.3 A unit intended for use in wet locations shall:

a) Be subjected to the environmental tests of 8.14 unless all live parts and traces on the printed wiring board are potted (see 6.7) or conformal coated (see 7.7.6),

b) If provided with a polymeric enclosure, comply with the UV Light Exposure and Cold Impact Test of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, using a preconditioning temperature of minus 35.0 ±2.0°C (minus 31.0 ±3.6°F), and

c) Be eligible to be marked as suitable for wet locations.

Exception: A circuit operating at Class 2 or LVLE power levels in which voltage levels are below those that present a risk of electric shock per 3.24 is not required to be subjected to parts (a) and (b) above.

6 Mechanical Construction

6.1 General

6.1.1 A unit intended to be used in an application identified by one of the standards specified in 1.3 shall comply with the mechanical construction requirements of that standard. If an end-use application is not specified or identified, or if a particular construction feature is not covered by the identified standard, the unit shall comply with the mechanical construction requirements of this section.

6.1.2 *Deleted*

6.1.3 Circuits that represent a risk of electric shock or risk of fire shall be provided with an electrical or fire enclosure that complies with 6.2 or 6.3.

6.1.4 An electrical or fire enclosure secured in place by adhesive shall comply with the Adhesive Support Test of 8.13. Fusion techniques, such as solvent cementing, ultrasonic welding, electromagnetic induction, and thermal welding are permitted without test.

6.1.5 In addition to complying with the construction requirements specified in this standard, a direct plug-in unit shall comply with the Mechanical Assembly, Input Connections, and Accessibility of Live Parts requirements specified in the Standard for Class 2 Power Units, UL 1310.

6.1.6 In addition to complying with the construction requirements specified in this standard, a LED controller that is intended to be installed in a wall-box (or provided with an enclosure for flush or surface mounting) shall comply with the following requirements in the Standard for Safety for Solid-State Dimming Controls, UL 1472 as applicable:

a) Means for mounting,

b) Current-carrying parts,

c) Switches,

d) Flush-device cover plates, and

e) Touch dimmers.

Note: This requirement applies to LED controllers that are not covered within the scope of the Standard for Safety for Solid-State Dimming Controls, UL 1472. See 1.1.3(b).

6.1.7 Where LED equipment includes coin cell lithium batteries, such as a wireless remote control for a LED controller, the design shall comply with the Standard for Products Incorporating Button or Coin Cell Batteries of Lithium Technologies, UL 4200A.

Exception: This requirement is not applicable to LED equipment where the battery is not intended to be user replaceable and is not referenced in the product markings or instructions sheet.

6.2 Metal parts

6.2.1 The thickness of a metal enclosure shall be in accordance with Table 6.1.

Exception: A part of an enclosure that complies with the mechanical strength tests for metal enclosures of 8.15 need not comply with the thickness specified in Table 6.1.

Table 6.1
Minimum thickness of metal enclosures

Metal	At small, flat, unreinforced surfaces and at surfaces of a shape or size to provide adequate mechanical strength		At surfaces to which a wiring system is to be connected in the field		At relatively large unreinforced flat surfaces	
	mm	(in)	mm	(in)	mm	(in)
Die-cast	1.2	(3/64)	–	–	2.0	(5/64)
Cast malleable iron	1.6	(1/16)	–	–	2.4	(3/32)
Other cast metal	2.4	(3/32)	–	–	3.2	(1/8)
Uncoated sheet steel	0.66	(0.026)	0.81	(0.032)	0.66	(0.026)
Galvanized sheet steel	0.74	(0.029)	0.86	(0.034)	0.74	(0.029)
Nonferrous sheet metal other than copper	0.91	(0.036)	1.14	(0.045)	0.91	(0.036)

6.2.2 All ferrous metal parts, including hinges, bolts, and fasteners, exposed after assembly shall be protected against corrosion by painting, coating, or plating, except for edges, punched holes, and spot welds in prefinished steel, enclosed steel pipe, and hanger locations for painting or plating. Copper, aluminum, alloys of copper and aluminum, stainless steel, and similar materials having inherent resistance to atmospheric corrosion are not required to have additional corrosion protection.

6.2.3 A protective coating need not be applied to steel enclosure parts when:

a) The interior of an enclosure is completely filled with potting compound,

b) Flat metal surfaces are tightly clamped together, or

c) Where not practical due to bearings, sliding surfaces of a hinge or shaft, hinge pins, and similar parts.

6.3 Polymeric materials

6.3.1 A polymeric material for which mechanical, electrical, or thermal characteristics are relied upon for compliance with the requirements of this standard shall have an electrical, mechanical with impact and mechanical with strength relative thermal index (RTI), or a generic thermal index as specified in the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, that is equal to or greater than the temperature measured during the Temperature Test, Section 8.3.

6.3.2 A polymeric material used as an electrical or fire enclosure shall comply with the minimum material characteristic requirements identified in Table 6.2.

Table 6.2
Polymeric enclosure requirements

Performance characteristic[a]	Function	
	Electrical enclosure	Fire enclosure
Impact[b]	X	X
UV Resistance[c]	X	X
Flammability		X[d,e,f]

Table 6.2 Continued on Next Page

Table 6.2 Continued

Performance characteristic[a]	Function	
	Electrical enclosure	Fire enclosure
Mold Stress	X	X
Comparative Tracking Index (CTI)		Performance Level Category (PLC) of 4[g]
Hot Wire Ignition (HWI)		PLC of 3[g]
High Ampere Arc (HAI)		PLC of 2[g]

[a] These characteristics are as specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. Polymeric parts with deficient minimum performance characteristics can be evaluated per applicable end-product requirements in UL 746C.

[b] 6.8 J (5 ft-lb) ball impact for dry or damp location, fixed or stationary units; 0.91 m (3 ft) drop impact for portable units. For damp or wet location, fixed units, the impact test is to be conducted after cold conditioning in accordance with UL 746C.

[c] For wet location units.

[d] V2 for portable units and track lighting luminaires.

[e] 5VA for fixed or stationary units. See 6.3.4 and 6.3.6 for additional options for secondary optics.

[f] Direct plug-in units are evaluated as portable units. A through cord unit with screw holes or other means for fastening in-place is considered a stationary unit. A through cord unit with keyholes only is considered a portable unit.

[g] Not required when all live parts are > 0.8 mm (0.030 in) from the material.

6.3.3 A conductive coating applied to a surface such as the inside surface of a cover, enclosure, and the like shall comply with the appropriate requirements for metallized parts in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, unless it can be determined that flaking or peeling of the coating does not result in a reduction of spacing of electrical parts or the bridging of live parts that may result in a risk of fire or electric shock.

6.3.4 With respect to footnote (e) of Table 6.2, if a fire barrier consisting of metal or of a polymeric material having a minimum flammability rating of 5VA is positioned between a circuit that represents a risk of fire and the secondary optic, the secondary optic need only be evaluated as an electrical enclosure per the requirements in Table 6.2. LED packages that comply with the applicable requirements of this standard (see Supplement SD) as suitable to form a part of an enclosure need not be covered by the fire barrier.

6.3.5 The lens of an LED package which is intended to form a part of the fire enclosure shall comply with the applicable requirements for LED packages in Supplement SD.

6.3.6 With respect to footnote (e) of Table 6.2, a secondary optic that serves as a fire enclosure where all live parts are insulated or spaced more than 0.8 mm (0.030 in) from the secondary optic shall have a minimum V0 rating.

6.3A Metal Enclosures intended for conduit connection

6.3A.1 Unthreaded openings for conduit and the area surrounding the opening shall comply with the requirements in Table 6.3.

Table 6.3
Dimensions of unthreaded opening for conduit and diameter of the area surrounding the opening

Nominal trade size of conduit	Unthreaded opening diameter[a]		On interior of component, minimum unobstructed diameter of flat surface surrounding conduit opening	
in	mm	(in)	mm	(in)
1/2	22.2	(0.875)	28.09	(1.11)
3/4	28.2	(1.109)	34.04	(1.34)
1	34.9	(1.375)	42.85	(1.69)
1-1/4	44.0	(1.734)	55.07	(7.10)

[a] A plus tolerance of 0.81 mm (0.032 in) and a minus tolerance of 0.38 mm (0.015 in) applies to the knockout diameter. Knockout diameters are to be measured other than at points where a tab attaches the knockout.

6.3A.2 A threaded opening for conduit shall comply with Table 6.4. When tapped all the way through, the opening shall have at least 3.5 but no more than 5 threads and comply with the minimum unobstructed diameter of flat surface in Table 6.3 to accommodate the conduit bushing. When not tapped all the way through, the opening shall have at least 5 threads.

Table 6.4
Throat diameters for conduit openings

Nominal trade size of conduit	Minimum throat diameter		Maximum throat diameter	
in	mm	(in)	mm	(in)
1/2	13.4	(0.528)	15.8	(0.622)
3/4	17.7	(0.697)	20.8	(0.819)
1	22.4	(0.882)	26.7	(1.051)
1-1/4	29.7	(1.169)	35.1	(1.382)

6.3A.3 A unit provided with a means of conduit connection shall be shipped with provision to close all but one of the conduit openings.

6.3A.4 Conduit closure plugs shall be suitable for the purpose with respect to environmental and enclosure flammability criteria.

6.3A.5 Conduit and other knockouts or twistouts shall be secured in place so they can be removed without distorting the enclosure but remain in place during normal handling, as determined by the Knockout Secureness Test, Section 8.17.

6.3A.6 Unless provided with a reliably separated wiring compartment, an opening provided for the purpose of making field connections to a branch circuit supply, shall be located greater than 152 mm (6 in) from the following:

a) Uninsulated live parts,

b) Low voltage circuitry,

c) Heat producing components,

d) Moving parts, and

e) Any electrical or mechanical component not specifically identified above that could result in an increased risk of fire or risk of shock.

6.3A.7 The area adjacent to an opening where branch circuit supply connections are to be made in the field and which has components located within 152 mm (6 in) of the opening shall be enclosed within a wiring compartment having a volume of at least 98 cm^3 (6 in^3) or as required by 6.3A.10, whichever is larger.

6.3A.8 A field-wiring compartment intended for connection of a wiring system shall be attached to the unit in a manner that will prevent it from turning.

6.3A.9 An outlet box, terminal box, wiring compartment, or the like in which connections to the unit will be made in the field shall be free from any sharp edge, including screw threads, a burr, a fin, a moving part, or the like, that may abrade the insulation on conductors or otherwise damage the wiring.

6.3A.10 The minimum volume of an integral field-wiring compartment for branch circuit connections shall be determined using Table 6.5. All conductors entering or leaving the compartment shall be included in the calculation; uninsulated grounding or bonding conductors integral to the unit are not to be included. Field wiring shall assume size 12 AWG (3.31 mm^2) conductors unless the ampacity of the unit requires larger conductors. A terminal block/push-in terminal that accepts small gauge wires (e.g., 18 AWG) requires use of wires [up to 152 mm (6 in)] to transition to branch circuit wiring (e.g., 12 AWG). These wires shall be included in the volume calculations.

Table 6.5
Determination of minimum wiring compartment volume

Conductor size	Volume per conductor	
AWG	cm^3	(in^3)
18	8.2	(0.5)
16	9.8	(0.6)
14	12.3	(0.75)
12	16.4	(1.0)
10	27.9	(1.7)

6.3A.11 An enclosure intended for pulling conductors shall be tested for rigidity as described in 8.19.

6.3A.12 An enclosure that is assembled using snap-in or tab-mounted parts without use of fastening methods such as screws, rivets, or welds shall be tested in accordance with 8.20.

6.4 Enclosure openings

6.4.1 Other than for supply connections, open holes shall not be permitted in any surface of a fire or electrical enclosures of LED equipment intended for conduit connection and LED equipment intended for installation in a concealed space.

Exception No. 1: Open holes are permitted in an enclosure intended for installation on or over an outlet box when the outlet box will serve to complete the enclosure of the equipment under test.

Exception No. 2: Open holes are permitted in an enclosure intended for installation to an exterior surface of a luminaire where the luminaire will serve to complete the enclosure of the equipment under test.

Exception No. 3: A maximum of four open holes are permitted on the inside mounting surface of an enclosure intended for conduit connection. The maximum area of each hole shall be 26 mm^2 (0.040 in^2).

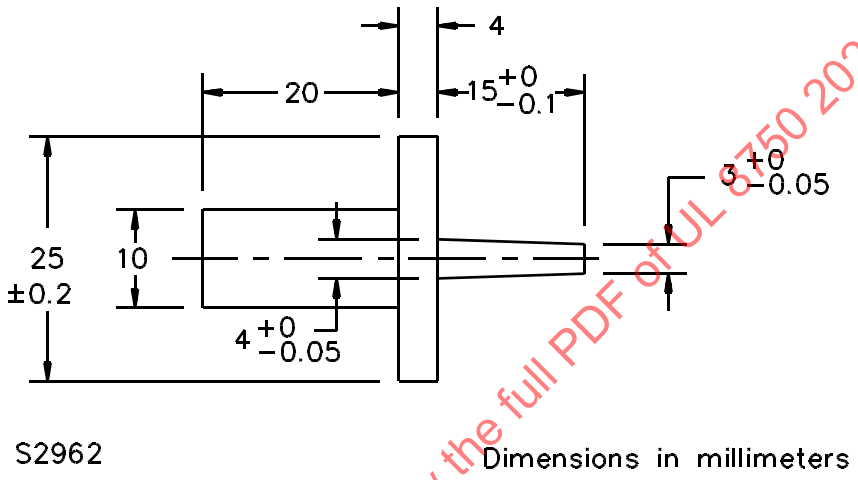
6.4.1.1 Direct plug-in or through-cord units may have openings, if circuits posing a risk of shock cannot be contacted due to the test instruments noted below being inserted through the openings applying a force not exceeding 4.45 N (1 lbf).

a) Test pin illustrated in Figure 6.1, and

b) Articulate probe illustrated in Figure 7.1.

Figure 6.1

Test pin



6.4.2 Open holes are permitted for LED equipment types not described in 6.4.1 and 6.4.1.1, subject to the accessibility criteria described in 7.2. Line of sight to open core and coil components shall be louvered or baffled.

6.5 Conductor protection

6.5.1 Conductors that pass over edges or through openings in metal shall be secured from contacting the edges or be protected from cutting and abrasion. For sheet metal less than 1.1 mm (0.042 in) thick, protection shall be provided by one of the following methods:

a) Rolling the edge of the metal not less than 120 degrees,

b) A bushing or grommet of a material other than rubber at least 1.2 mm (0.047 in) thick, or

c) Glass sleeving at least 0.25 mm (0.010 in) thick.

6.6 Strain relief

6.6.1 A strain relief and cord pushback device or positive mechanical means shall be provided to facilitate compliance with the test requirements of 8.10. This requirement applies when a supply cord or field wiring lead wire operates above the limits for risk of fire or electric shock, and its displacement could result in:

a) Subjecting the supply cord or field wiring lead to mechanical damage,

b) Exposing the supply cord or field wiring lead to a temperature higher than that for which it is rated,

c) Reducing spacing (such as to a metal strain-relief clamp) below the minimum required values, or

d) Damage to internal connections or components.

Exception: A supply cord or field wiring lead wire embedded in a potting compound inside the enclosure at the supply cord or lead wire entrance is considered to provide the necessary positive mechanical means.

6.7 Polymeric potting compound

6.7.1 Polymeric potting compound shall not leak, drip, or be released from a unit during any test conducted in accordance with this standard.

6.7.1.1 In a given design – the type of polymeric potting compound, the potting process and the volume of potting compound (case fill percentage) are considerations to confirm acceptability based on the specific application. When inorganic materials (e.g. quartz, sand, etc.) are mixed in with a polymeric potting compound, additional consideration is necessary to confirm acceptability based on the specific application.

6.7.2 During the Temperature Test of 8.3, a polymeric potting compound shall not exceed its Relative Thermal Index (RTI).

Exception No. 1: Thermosetting materials are exempt from this requirement.

Exception No. 2: Thermoplastic materials may be used if the maximum potting compound temperature doesn't exceed 90°C (194°F).

Exception No. 3: Thermoplastic materials may be used if the maximum potting compound temperature is at least 15°C (27°F) less than the softening point of the compound as determined by the Standard Test Methods for Softening Point of Resins Derived from Pine Chemicals and Hydrocarbons, by Ring-and-Ball Apparatus, ASTM E28.

Exception No. 4: Thermoplastic materials may be used if the maximum potting compound temperature is at least 25°C (77°F) less than the softening point of the compound as determined by the Standard Test Methods for Vicat Softening Temperature of Plastics, ASTM D1525.

6.7.3 Polymeric potting compound that can touch any part of the insulation system of a transformer shall be tested in accordance with Supplement SA – Substitutions or Modification to an Electrical Insulation System in the Standard for Systems of Insulating Materials – General, UL 1446.

Exception No. 1: This test does not apply if the transformer is not used for the mitigation of the risk of electric shock or is not used to separate Class 2 circuits or LVLE circuits from hazardous circuits.

Exception No. 2: This test does not apply if the transformer insulation system already includes the potting.

Exception No. 3: This test does not apply if the insulation system is used up to the temperature permitted for class 105 (A) according to Table 8.1 of this standard.

Exception No. 4: This test does not apply for thermosetting potting compounds where the insulation system of a transformer utilizes a thermoset varnish which completely encloses the coil windings-preventing the potting compound from making contact with the winding wire insulation.

6.8 Asphalt potting compound

6.8.1 Asphalt potting compound shall not leak, drip, or be released from a unit during any test conducted in accordance with this standard.

6.8.2 The volume of asphalt potting compound (case fill percentage) is a consideration to confirm acceptability based on the specific application.

6.8.3 During the Temperature Test of 8.3, asphalt potting compound shall remain at least 15°C (27°F) below its softening point as determined by the Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus), ASTM D36/D36M.

7 Electrical Construction

7.1 General

7.1.1 A unit intended to be used in an application identified by one of the standards specified in 1.3 shall comply with the electrical construction requirements of that standard. If an end-use application is not specified or identified, or if a particular construction feature is not covered by the identified standard, the unit shall comply with the electrical construction requirements of this section.

7.1.2 A current-carrying part shall be gold, silver, copper, a copper alloy, plated iron or steel, stainless steel, or other corrosion-resistant alloys acceptable for the application.

Exception: Trace conductors and wire bonds on a printed wiring board are permitted to be of aluminum.

7.1.3 An uninsulated live part shall be secured so that it does not turn or shift in position if such motion results in a reduction of spacings below the minimum acceptable values.

7.1.4 Friction between surfaces is not acceptable as a means to prevent shifting or turning of a live part but a lock washer is acceptable.

7.2 Accessibility

7.2.1 A live part that is a risk of electric shock shall be located or guarded by an enclosure or barrier so it is inaccessible to contact, by persons while using the product as intended, using the articulate probe shown in Figure 7.1, applying a force not exceeding 4.45 N (1 lbf).