



UL 2108

Underwriters Laboratories Inc. Standard for Safety

Low Voltage Lighting Systems



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UL Standard for Safety for Low Voltage Lighting Systems, UL 2108

First Edition, Dated February 27, 2004

Summary of Topics

These revisions to ANSI/UL 2108 are being issued to address universal upkeep of UL Standards for Safety. These revisions are considered to be non-substantive and not subject to UL's STP process.

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. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

In the revisions dated July 16, 2009, pages 19, 20, 45, and 46 have been intentionally deleted from the Standard due to the deletion or relocation of text.

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

Future Effective Date	References
July 16, 2012	Paragraphs 28.1, 28.1.1, 29.1, 29.1.1, 51.3, 51.4, 53.1, 53.2, 53.3, 53.4, 58.2, 81A.1, and 81A.2

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This ANSI/UL Standard for Safety consists of the First Edition including revisions through November 20, 2009.

The most recent designation of ANSI/UL 2108 as an American National Standard (ANSI) occurred on July 16, 2009. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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INTRODUCTION

1 Scope

Effective date for 1 changed from February 27, 2007 to October 15, 2008

1.1 These requirements apply to low voltage lighting systems and components intended for permanent installation and for use in locations in accordance with the National Electrical Code, ANSI/NFPA 70, Article 411.

1.2 These requirements cover:

- a) Low voltage lighting power units and luminaires;
- b) Low-voltage exposed conductor lighting systems; and
- c) Class 2 low voltage lighting systems.

Revised 1.2 effective October 15, 2008

1.3 These requirements do not cover low-voltage lighting systems and luminaires covered by other standards such as, but not limited to, the Standard for Portable Electric Luminaires, UL 153, the Standard for Track Lighting Systems, UL 1574, the Standard for Luminaires, UL 1598, the Standard for Low Voltage Landscape Lighting Systems, UL 1838, low voltage lighting systems that operate at over 25 amperes, or low voltage luminaires with integral power supplies.

Revised 1.3 effective October 15, 2008

2 Units of Measurement

Effective date for 2 changed from February 27, 2007 to October 15, 2008

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

3 Glossary

Effective date for 3 changed from February 27, 2007 to October 15, 2008

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

3.2 ACCESSIBILITY BARRIER – A material provided to limit access to uninsulated current-carrying parts that involve a risk of shock and insulated current-carrying parts not intended to be subject to user contact.

3.3 CABINET MOUNTED UNIT – A luminaire or power unit intended for final installation into cabinets and similar location, such that all or part of the unit is located within the interior space of the cabinet.

3.4 CONDUCTORS, INSULATED – A conductor encased within material recognized as electrical insulation.

3.5 ENCLOSURE – A material provided to enclose electrical parts and components that involve a risk of fire. All or part of the enclosure is not prohibited from also serving as an accessibility barrier or recessed housing.

3.6 EXPOSED CONDUCTORS – Low voltage supply conductors, which provide physical support and electrical supply connections for one or more luminaire assemblies, including assemblies capable of being repositioned along the length of the conductors. Exposed conductors include the following types:

- a) Exposed bare conductors intended for use with a power unit provided with integral protection against inadvertent shorting and overloading; or
- b) Exposed insulated conductors provided with integral protection against inadvertent shorting by insulation or an insulated coating.

3.7 LAMP CONTAINMENT BARRIER – Any part of the luminaire that surrounds the lamp to contain hot particles of the lamp in the event that it ruptures.

3.8 LOCATION, DAMP – 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.

3.9 LOCATION, DRY – 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.

3.10 LOCATION, WET – A location in which water or other liquid may drip, splash, or flow on or against electrical equipment.

3.11 LUMINAIRE – A complete lighting unit designed to accommodate a lamp and to connect the lamp to a power source.

3.11.1 NOMINAL OUTPUT WATTAGE/LOAD – Specified by power unit or system manufacturer as total lamp wattage. Assumes that lamps are operating at rated lamp voltage.

Added 3.11.1 effective October 15, 2008

3.12 OPENING – An aperture in an enclosure that is covered or filled by a plug or knockout and that has the potential of becoming an open hole.

3.13 OPEN HOLE – An aperture in an enclosure or a recessed housing that is not covered or filled by another part.

3.14 POWER UNIT – The equipment that powers and controls the luminaires in a low voltage lighting system. A power unit has the following characteristics:

- a) An isolating type transformer or electronic power supply of output voltage not exceeding 30 V rms;
- b) Is intended for field installation; and
- c) Each secondary circuit is limited to 25 amperes.

3.15 RECESSED HOUSING – A part of a recessed luminaire or power unit that projects into the ceiling or wall cavity and serves to close off the opening from the room side, and does not necessarily enclose conductors or similar components.

3.16 RECESSED UNIT – A luminaire or power unit that is designed to be either wholly or partially recessed in a mounting surface.

Thermally Protected Type IC – A recessed luminaire or power unit that is designed and identified for installation in a cavity filled with thermal insulation. The unit may be in direct contact with combustible materials and the insulation.

Type Non-IC, Thermally Protected – A recessed luminaire or power unit that is designed for installation in a cavity with minimum dimensions and spacings to thermal insulation and combustible material that comply with the installation code. It is not intended to be in contact with or covered with combustible materials and insulation.

Type Non-IC, Concrete Only – A luminaire or power unit that is not provided with thermal protection because it is investigated and identified for installation only in poured concrete.

Inherently Protected – A luminaire or power unit that is investigated and identified for installation in a cavity where the unit is in direct contact with thermal insulation or combustible materials and the construction is such that, even without a thermal protector, a luminaire is unable to be overlamped or mislamped, or a power unit overloaded to the extent that operating temperatures are exceeded in accordance with the prescribed limits in Table 34.1.

3.17 RISK OF ELECTRIC SHOCK – A risk of shock exists between any two uninsulated conductive parts or between an uninsulated conductive part and earth ground, if the continuous current flow through a 1500 Ω resistor in parallel with a 0.015 μF capacitor connected between the two points exceeds a 5 mA rms (7 mA peak) and if the open circuit voltage exceeds 30 V rms (42.4 V peak) for dry and damp or 15 V rms (21.2V peak) for wet locations.

3.18 SURFACE MOUNT UNIT – A luminaire or power unit that is designed to be mounted directly to a wall or ceiling surface.

3.19 ULTRAVIOLET (UV) FILTER – A portion of the luminaire that limits ultraviolet (UV) emissions.

3.20 UNDER-CABINET OR SHELF-MOUNTED UNIT – A luminaire and/or power unit intended for surface or blind hole mounting under a cabinet or shelf, where the unit does not extend through the mounting surface or into the cabinet interior.

3.21 UNIT – For purposes of the standard the term “unit” includes luminaires and power units.

4 Components

Effective date for 4 changed from February 27, 2007 to October 15, 2008

4.1 Except as indicated in 4.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

4.2 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.

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

4.4 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.

5 Undated References

Effective date for 5 changed from February 27, 2007 to October 15, 2008

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

6 Organization and Application

Effective date for 6 changed from February 27, 2007 to October 15, 2008

6.1 The standard is organized as follows:

Part 1 – Covers the construction, performance, and marking requirements for all power units.

Part 2 – Covers exposed bare conductor luminaires and Class 2 luminaires used with power units covered in Part 1.

PART I – POWER UNITS

GENERAL

7 General

Effective date for 7 changed from February 27, 2007 to October 15, 2008

7.1 These requirements apply to the power units in a low voltage lighting systems.

7.2 The maximum rating of a power unit shall not exceed 30 volts, 25 amperes per circuit under any conditions of load.

7.3 The low voltage secondary circuit shall be isolated from the primary circuit and shall not be grounded.

CONSTRUCTION – MECHANICAL

8 General Construction

Effective date for 8 changed from February 27, 2007 to October 15, 2008

8.1 Insulated 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 0.042 in. (1.1 mm) thick, protection shall be provided by one of the following methods:

- a) Rolling the edges of the metal not less than 120 degrees;
- b) A bushing or grommet of a material other than rubber at least 0.047 in. (1.2 mm) thick;
- c) Glass sleeving at least 0.010 in. (0.25 mm) thick; or
- d) Other means that provide equivalent protection.

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8.2 A component such as a lampholder, switch, or other part of an assembly shall be restricted from loosening or turning when such motion adversely affects the intended performance of a component, a reduction of electrical spacings, or results in a risk of fire. Friction alone does not meet the intent of restriction of movement. The use of a lock washer, a star washer, dimples, upturned lugs, ears, and similar means meets the intent of the requirement for this purpose.

9 Enclosure

Effective date for 9 changed from February 27, 2007 to October 15, 2008

9.1 All splices, current-carrying parts, devices with current-carrying parts that do not have integral enclosures or are not protected as specified in Section 30, Exposed Bare and Insulated Conductors, and all leads or terminals for field connection of supply wires shall be enclosed in material specified in 9.2 – 9.4.

9.2 The thickness of sheet and extruded metal in a power unit enclosure shall be in accordance with Table 9.1.

Table 9.1
Minimum thickness of sheet metal and extruded aluminum for enclosures

Specific construction		Steel				Copper, brass, aluminum sheet, and extruded aluminum			
		Unreinforced		Reinforced		Unreinforced		Reinforced	
		mm	(in)	mm	(in)	mm	(in)	mm	(in)
At opening for conduit connection		0.66	(0.026)	0.66	(0.026)	0.81	(0.032)	0.81	(0.032)
Length more than 660 mm (26 in)	No electrical component support	0.51	(0.020)	0.41	(0.016)	0.56	(0.022)	0.43	(0.017)
	Electrical component support	0.66	(0.026)	0.51	(0.020)	0.71	(0.028)	0.56	(0.022)
Length not more than 660 mm (26 in)	No electrical component support	0.41	(0.016)	0.33	(0.013)	0.51	(0.020)	0.41	(0.016)
	Electrical component support	0.51	(0.020)	0.41	(0.016)	0.64	(0.025)	0.51	(0.020)
Length not more than 380 mm (15 in)	No electrical component support	0.41	(0.016)	0.33	(0.013)	0.51	(0.020)	0.41	(0.016)
	Electrical component support	0.41	(0.016)	0.41	(0.016)	0.51	(0.020)	0.51	(0.020)

Notes:

- (1) Reinforced – a form of construction that provides equivalent mechanical strength.
- (2) No electrical component support – the minimum thickness required for mounting of non-electrical parts.
- (3) Examples of acceptable methods of reinforcement are:
 - a) a single piece of sheet metal that is formed to result in a maximum internal angle of 120 degrees;
 - b) 13 by 13 mm (0.5 by 0.5 in) 90 degrees formed from sheet steel, 8.1 mm (0.266 in) minimum thickness, used to divide a surface into small sections and, unless along the greater dimension, are additionally secured to the adjacent sides of the enclosure;

Table 9.1 Continued on Next Page

Table 9.1 Continued

Specific construction	Steel				Copper, brass, aluminum sheet, and extruded aluminum			
	Unreinforced		Reinforced		Unreinforced		Reinforced	
	mm	(in)	mm	(in)	mm	(in)	mm	(in)
c) flat steel bars, 9.5 mm (0.375 in) wide minimum, 3.2 mm (0.125 in) thick minimum, used and secured as in (b); and d) curved, ribbed, or flanged surfaces. A surface is considered to be flanged if the two opposite sides are bent 13 mm (0.50 in) or wider at right angles to the surface. (4) For coated or finished metals, the minimum thickness is considered to be obtained if the overall thickness exceeds that required in Table 9.1 by at least 0.013 mm (0.0005 in) for each side coated or finished. (5) Length – the longest straight line that can be drawn on any unreinforced flat section.								

9.3 The thickness of an enclosure material constructed of cast metal shall be in accordance with Table 9.2.

Table 9.2
Minimum thickness of cast metal for enclosures

Material	Unreinforced		Reinforced	
	in	(mm)	in	(mm)
Cast metal	0.126	(3.2)	0.094	(2.4)
Cast malleable iron	0.094	(2.4)	0.063	(1.6)
Permanent mold – cast aluminum	0.094	(2.4)	0.063	(1.6)
Die cast metal	0.079	(2.0)	0.047	(1.2)
Note: Reinforced dimensions are usable at the root of threads, a surface that is curved or otherwise reinforced; and for a surface of such shape, or size, or both, that the strength contemplated is provided. Areas for breakouts, or similar reasons, are able to have thinner sections, when the strength of structure is not affected, and in no case thinner than required for sheet metal.				

9.4 An enclosure formed of a polymeric material, shall comply with the following:

- a) Mechanical strength – the impact evaluation in Section 41, Impact Test;
- b) Combustibility – minimum flammability rating of 5 VA;
- c) Mold stress – the mold stress evaluation in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, shall be performed by the air oven method; and
- d) Temperature – the material shall possess a mechanical with impact and electrical temperature index of at least the temperature measured on the part during the normal temperature test.

Exception: When the temperature measured during the normal temperature test is less than 65°C (149°F), the enclosure is not required to comply with (d).

9.5 A polymeric material relied upon to provide all or a portion of the strain relief shall comply with the requirements of the Strain Relief for Flexible Cord Test, Section 42, after the Mold Stress Relief Distortion Test in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

10 Openings

Effective date for 10 changed from February 27, 2007 to October 15, 2008

10.1 All splices, open coil devices, capacitors, leads or terminals for field connection of supply wires, other arcing live parts, or current-carrying parts involving a risk of fire or shock shall be provided with an enclosure of a material specified in Section 9, Enclosures, without any open holes.

Exception: Open holes are able to be used when all uninsulated current-carrying parts or splices involving a risk of shock as defined in 3.17 are not accessible by the accessibility probe shown in Figure 22.1 and the open holes do not exceed the dimensions specified in 10.2.

Revised 10.1 effective October 15, 2008

10.2 An open hole in the enclosure shall not exceed 1-1/2 square inches (968 mm²) in area, and the total area of one or more open holes shall not be more than 15 percent of the area of the surface in which the hole or holes are located.

10.3 An enclosure containing a fuse mounted in an open type fuseholder shall have no open holes.

Exception: Openings in an enclosure containing an open type fuseholder are able to be located 6 inches (152 mm) or more from the fuse, measured horizontally, when the power unit is mounted as intended.

10.4 The provisions for openings in a recessed housing shall be as follows:

- a) An open hole in the shape of a slot or louver provided in the recessed housing shall be no more than 3/8 inch (9.5 mm) in width nor more than 1-1/2 square inches (9.7 cm²) in area, and any other open hole shall be no more than 1 inch (25.4 mm) in diameter. The total area of all open holes shall be no more than 15 percent of the area of the inside diameter of the recessed housing or plaster frame where the housing or frame passes through the hole in the mounting surface.
- b) The recessed housing of a product marked for use in poured concrete or in ground shall contain no open holes.
- c) The recessed housing of a product marked "TYPE IC RECESSED" shall contain no open hole as a slot or louver larger than 3/16 inch (4.8 mm) in width or more than 1-1/2 square inches (9.7 cm²) in area. Any other shape of an open hole shall be such that it does not permit the entrance of a 1/4 inch (6.4 mm) diameter rod.

11 Recessed Housings

Effective date for 11 changed from February 27, 2007 to October 15, 2008

11.1 A recessed product shall be constructed such that a hole in a ceiling or wall structure is closed off by the recessed housing. All current-carrying parts shall be located on the room side of the housing unless they are enclosed as specified in Section 9, Enclosure.

11.2 A sheet metal recessed housing shall have a minimum thickness of 0.026 inch (0.66 mm) when of steel, and 0.028 inch (0.71 mm) when of aluminum or copper alloy.

11.3 A polymeric recessed housing shall have a minimum flammability rating of 5 VA and shall be marked as specified in 48.5.7.

12 Corrosion Protection

Effective date for 12 changed from February 27, 2007 to October 15, 2008

12.1 Ferrous metal parts of the enclosure not inherently corrosion resistant shall be protected against corrosion by enameling, galvanizing, zinc or cadmium plating, or other equivalent means.

12.2 Edges, punched holes, and spot welds in prefinished steel, enclosed steel pipe, and hanger locations for painting or plating in ferrous metals do not require any corrosion protection.

13 Damp and Wet Locations

Effective date for 13 changed from February 27, 2007 to October 15, 2008

13.1 The requirements specified in this section apply to power units marked "Suitable for Damp Locations" or "Suitable for Wet Locations" as defined by 3.8 and 3.10.

13.2 All products marked for wet locations in accordance with 48.1.8 shall comply with the additional wet location construction and performance requirements of the Standard for Luminaires, UL 1598.

13.3 Power units marked for wet locations shall comply with the transformer requirements of 17.3.

13.4 All products marked suitable for damp locations in accordance with 48.1.9 shall comply with the following:

- a) Ferrous metal parts shall be protected against corrosion in accordance with 12.1; and
- b) The product shall not be provided with any information such as markings, instructions, or illustrations either on the carton or with the product that implies or depicts a wet location use.

13.5 Power units intended for exposed bare conductor lighting systems shall not be marked suitable for wet or damp locations.

CONSTRUCTION – ELECTRICAL

14 Current-Carrying Parts

Effective date for 14 changed from February 27, 2007 to October 15, 2008

14.1 All current-carrying parts shall be made of copper or copper alloy.

Exception: Aluminum and aluminum alloys are permitted to conduct current in the output circuit of exposed bare conductor lighting systems.

15 Conductors and Cords

Effective date for 15 changed from February 27, 2007 to October 15, 2008

15.1 Wiring not protected in accordance with Section 30, Exposed Bare and Insulated Conductors, shall consist of general use wire or appliance wiring material with insulation rated for the maximum temperature and voltage of the unit.

15.2 Conductors shall be 18 AWG (0.82 mm²) minimum.

Exception No. 1: Conductors located in a Class 2 circuit shall be 24 AWG (0.21 mm²) minimum.

Exception No. 2: Conductors of a size smaller than 18 AWG, but not smaller than 24 AWG, may be used under the following conditions:

- a) Where they are completely enclosed;*
- b) Where they are not subject to movement under normal use; and*
- c) In the secondary of a transformer, or in a circuit using solid-state devices.*

15.3 The maximum ampacity of wire and cord with copper conductors shall be in accordance with Table 15.1.

Exception: A conductor is not required to be sized in accordance with Table 15.1 when it complies with the Direct-Current Bus-Bar or Conductor Resistance Test described in the Standard for Track Lighting Systems, UL 1574.

Table 15.1
Maximum ampacities of wire and cords

Types of wire and cord ^a	Ampacity ^b				
	18 AWG (0.82 mm ²)	16 AWG (1.3 mm ²)	14 AWG (2.1 mm ²)	12 AWG (3.3 mm ²)	10 AWG (5.3 mm ²)
General building wire (Conductors for general wiring)	—	—	20	25	30
Fixture wire	6	8	17	23	28
Flexible cord ^c	10	13	18	25	30
Appliance wiring material	6	8	17	23	28

^a Except for appliance wiring material, see the National Electrical Code, ANSI/NFPA 70, for required wire and cord types covered by these designations.
^b The SI equivalent for each conductor size is shown in parentheses in terms of cross-sectional area.
^c These ampacities are applicable to 2-conductor cords carrying current.

16 Splices and Connections

Effective date for 16 changed from February 27, 2007 to October 15, 2008

16.1 A splice shall be made with solder or a wire connector and shall be electrically and mechanically secure.

16.2 An insulated splice or connector shall be provided with insulation that has temperature and voltage ratings equal to or greater than required for the conductor insulation.

16.3 Deleted December 21, 2007

16.4 Insulation displacement and piercing connections in other than a Class 2 circuit shall comply with Part 3.

17 Transformer

Effective date for 17 changed from February 27, 2007 to October 15, 2008

17.1 The primary and secondary windings of a transformer shall be isolated and comply with one of the following:

- a) Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1, and Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2;
- b) Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1, and Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3;
- c) Transformer and Motor Transformers for Use in Audio-, Radio- and Television-Type Appliances, UL 1411;
- d) Low Voltage Landscape Lighting Systems, UL 1838
- e) Power Units Other Than Class 2, UL 1012; or

f) Class 2 Power Units, UL 1310.

17.1 revised July 16, 2009

17.2 A Class 2 power unit employing a transformer shall comply with the Class 2 requirements of 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, or the Class 2 Power Units, UL 1310 .

17.2 revised July 16, 2009

17.3 The construction of a transformer in a power unit marked suitable for wet locations shall include at least one of the following:

- a) Primary and secondary windings mounted on separate sections of the core;
- b) Primary and secondary windings separated by a shield of copper minimum 0.002 inches (0.051 mm) thick, or brass, minimum 0.005 inches (0.127 mm) thick;
- c) A flanged bobbin-wound construction that complies with the Standard for Power Units Other than Class 2, UL 1012;
- d) A split bobbin construction and comply with the requirements for double insulation in the Standard for Double Insulation Systems for Use in Electrical Equipment, UL 1097, or the Standard for Reference Standard for Double Insulation Systems for Use in Electronic Equipment, UL 2097;
- e) Comply with the Standard for Transformers and Motor Transformers for Use in Audio-, Radio- and Television-Type Appliances, UL 1411, construction, performance, and 3500 V rms dielectric voltage withstand test requirements; or
- f) Comply with the Class 2 requirements 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, or the Class 2 Power Units, UL 1310.

17.3 revised July 16, 2009

17.4 The shield in 17.3(b) shall be bonded to the transformer core and to the power unit grounding means.

Exception: Bonding the shield to the core is not required for a toroidal type transformer when the transformer is isolated from ground.

17.5 A connection shall be made between the shield and ground by means of a bonding lead sized at least as large as the conductor used to supply the primary winding magnet wire, and shall be no smaller than 18 AWG (0.82 mm²).

18 Electronic Power Supply

Effective date for 18 changed from February 27, 2007 to October 15, 2008

18.1 The primary and secondary circuit of the power supply shall be isolated and comply with one of the following standards:

- a) Power Units Other Than Class 2, UL 1012;
- b) Class 2 Power Units, UL 1310; or
- c) Information Technology Equipment, UL 60950.

18.2 A Class 2 power unit employing an electronic power supply shall comply with the Class 2 requirements of the Standard for Class 2 Power Units, UL 1310.

18.3 An electronic power unit shall be provided with a means to isolate the primary from the secondary such as optical isolators that comply with the Standard for Optical Isolators, UL 1577, or transformers that comply with Section 17, Transformers.

19 Protective Devices

Effective date for 19 changed from February 27, 2007 to October 15, 2008

19.1 Each output of the power unit shall be limited to a maximum of 25 amperes.

19.2 An overcurrent protective device shall comply with the appropriate Standard.

19.3 A nonresettable thermal protective device shall be inaccessible and shall be located within the enclosure.

19.4 An automatic reset protective device shall comply with the 6,000 Cycle Endurance Test in the Standard for Electrical Temperature-Indicating and -Regulating Equipment, UL 873.

19.5 For an exposed bare conductor lighting system, a power unit having available power exceeding Class 2 limits shall be provided with integral protection against inadvertent shorting and overloading. The effectiveness of the protection shall be evaluated by compliance with the Exposed Bare Conductor Abnormal Operation Test described in Section 38.

Exception: The Exposed Bare Conductor Abnormal Operation Test is not required for low-voltage exposed insulated conductor systems as described in 30.1(b), 30.1(c), or 30.1(d).

19.6 A recessed product shall be provided with thermal protection rated for the maximum rated load it controls and comply with the requirements for thermal protective devices for lighting fixtures or fluorescent lamp ballast protectors, as specified in the Standard for Temperature-Indicating and -Regulating Equipment, UL 873.

Exception No. 1: A power unit marked for use only in poured concrete or in-ground as specified in 48.5.3 is not required to be provided with thermal protection.

Exception No. 2: Thermal protection is not required to be provided on an inherently protected power unit that operates within the Type IC temperature limits in Table 34.1 with the maximum rated load and is marked in accordance with 48.5.1(c).

20 Electronic Circuits

Effective date for 20 changed from February 27, 2007 to October 15, 2008

20.1 The requirements in this section do not apply to components located in a Class 2 circuit.

20.2 A printed wiring board, including coatings, when provided shall comply with the requirements in the Standard for Printed-Wiring Boards, UL 796, and shall be classified V-0, V-1, or V-2 in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

20.3 A resistor, capacitor, inductor, transformer, or other part that is mounted on a printed wiring board to form a printed-wiring assembly shall be secured so that the risk of displacement by any force exerted on it is minimized.

20.4 A circuit involving a capacitor, rectifier, transistor, or similar component is to be subjected to analysis to determine whether there is a risk of fire or electric shock when the component is opened or shorted. The possible effect of one component on another, encapsulation, and similar factors are to be considered. When a risk is determined to exist, the Component Fault Test, Section 39 is to be conducted.

21 Switches

Effective date for 21 changed from February 27, 2007 to October 15, 2008

21.1 The requirements in this section do not apply to components located in a Class 2 circuit.

21.2 A switch shall have a minimum ampere rating equal to the total load current it controls multiplied by the load factor shown in Table 21.1.

Table 21.1
Switch rating load factor

Type of load	Special use switches				General use switches
	L-rated (ac only)	T-rated (ac/dc)	Ampere rated (ac only)	Ampere rated (ac/dc)	Ampere rated (ac only)
Tungsten filament	1	1	3	3	1
Inductive	1	1	2	2	1
Resistive	1	1	1	1	1

22 Accessibility to Live Parts

Effective date for 22 changed from February 27, 2007 to October 15, 2008

22.1 An uninsulated current-carrying part or a splice connection involving a risk of shock as defined by 3.17 shall be inaccessible to unintentional contact by persons during use.

Revised 22.1 effective October 15, 2008

22.2 An uninsulated current-carrying part or a splice connection is determined to be accessible when it is contacted by the articulated probe shown in Figure 22.1.