UL 2161

STANDARD FOR SAFETY

Neon Transformers and Power Supplies

UL Standard for Safety for Neon Transformers and Power Supplies, UL 2161

Second Edition, Dated April 6, 2016

Summary of Topics

The second edition of UL 2161 is being issued to address the editorial maintenance of UL Standards for Safety and to remove the reference of the withdrawal date for UL 873. Any changes that were made are considered to be non-substantive and not subject to UL's STP process.

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Standard for Neon Transformers and Power Supplies

First Edition – September, 1996

Second Edition

April 6, 2016

This UL Standard for Safety consists of the Second edition.

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 http://csds.ul.com.

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PART 1 – ALL NEON SUPPLIES

INTRODUCTION

1 Scope

1.1 This standard applies to transformers and power supplies, including those intended to be connected to a Class 2 source of supply, that provide the voltage and ballasting for neon and cold-cathode tubing (electric-discharge tubing) consisting of electrodes and gas such as neon, mercury, helium, argon, and similar gases, enclosed in glass. Neon transformers and power supplies for use in signs and outline lighting are intended to be used in accordance with Article 600 of the National Electrical Code, NFPA 70. Cold-cathode supplies identified for use only in cold-cathode lighting systems are intended to be used in accordance with Article 410 of the National Electrical Code.

1.2 Neon transformers and power supplies covered by this standard are designated by their construction and intended use as specified in Table 1.1.

1.3 The following neon supplies are only covered as components for use in an end product that is determined to comply with the Standard for Electric Signs, UL 48:

a) Type 1 neon supplies;

b) Types 5 and 6 neon supplies when complying with Exception No. 3 to 23.1;

c) Types 6, 7, and 8 neon supplies when complying with the Exception to 14.4.1 or the Exception to 14.4.3;

d) All types of neon supplies having an isolated output when complying with Exception No. 2 to 23.1; and

e) Cold-cathode supplies when complying with Exception No. 5 to 23.1.

1.4 These requirements do not cover transformers or power supplies intended to supply other forms of electric-discharge lighting sources such as fluorescent and high-intensity-discharge lighting. Requirements for fluorescent supply sources are covered in the Standard for Fluorescent-Lamp Ballasts, UL 935, and the requirements for high-intensity-discharge lighting supply sources are covered in the Standard for High-Intensity-Discharge Lamp Ballasts, UL 1029.

1.5 These requirements do not cover transformers or power supplies that are intended for use with oil burners. The requirements for oil ignition transformers are covered in the Standard for Low Voltage Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers – Part 2: General Purpose Transformers, UL 5085-2, and for oil ignition power supplies are covered in the Standard for Power Units Other Than Class 2, UL 1012.

Table 1.1
Construction type designation

Core and/or circuitry		Primary connections			Secondary connections			Type designations
		Wiring terminals or leads			Wiring terminals or leads			
Completely enclosed[a]	Any part exposed[b]	Exposed – not in wiring compartment or through conduit fitting	Unexposed – in wiring compartment or through conduit fitting	Power supply cord	Exposed – not in wiring compartment or through conduit fitting	Unexposed – in wiring compartment or through conduit fitting	Inte-gral recep-tacles	Type designation number – see numbered footnotes for definition
no	yes	yes	no	no	yes	no	no	1
yes	no	yes	no	no	yes	no	no	2
yes	no	no	yes	no	yes	no	no	3
yes	no	no	yes	no	no	yes	no	4
yes	no	no	yes	no	no	no	yes	5
yes	no	no	no	yes	no	no	yes	6
yes	no	no	no	yes	yes	no	no	7
yes	no	no	no	yes	no	yes	no	8

[a] – Enclosed is the containment of electrical parts in a material that complies with 7.1.

[b] – Exposed is any current carrying part other than input and output leads or terminals that is not contained in accordance with 7.1.

Type 1 – Open core-and-coil transformer or open power supply that requires a complete enclosure in the end product.

Type 2 – Neon supply with the input and output terminals, leads, and connections enclosed in the end product.

Type 3 – Neon supply with input leads or terminals enclosed and intended for connection to a permanent wiring system, and with secondary leads or terminals required to be enclosed in the end product.

Type 4 – Neon supply that is fully enclosed including the output and is intended for connection to a permanent wiring system.

Type 5 – Neon supply that is fully enclosed and intended for connection to a permanent wiring system, and is provided with integral output receptacles.

Type 6 – Cord-connected neon supply provided with integral output receptacles.

Type 7 – Cord-connected neon supply with secondary output leads or terminals needing to be enclosed in the end product.

Type 8 – Cord-connected neon supply with enclosed output leads or terminals.

2 Components

2.1 Except as indicated in 2.2, 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 used in the products covered by this standard.

2.2 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.

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

2.4 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.

3 Reference Publications

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

4 Units of Measurement

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

4.2 Unless otherwise indicated, all voltage and current values mentioned in this standard are root-mean-square (rms).

5 Terminology

5.1 As used in these requirements, terms are used to refer to particular parts or features as indicated in Table 5.1.

Table 5.1
Terminology chart

Terms	Refers to:
Input	Primary winding input of a transformer and the input of a power supply
Neon power supply	Electronic power supply
Neon supply	A neon transformer, neon power supply, cold-cathode transformer, and a cold-cathode power supply
Neon transformer	Ferromagnetic transformer supply
Output	Secondary winding output of a neon transformer and the output of a power supply
Secondary ground-fault protection	Ground-fault protection that responds to a ground-fault on the secondary of a neon transformer or on the output of a neon power supply

6 Glossary

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

6.2 ACCESSIBILITY BARRIER – A material provided to limit access to uninsulated live parts and to live parts insulated with materials not intended to be subject to user contact. See Enclosure, 6.12, when an accessibility barrier also serves as an enclosure.

6.3 ADHESIVE – A bonding material (such as epoxy, paste, cement) placed between parts to be fastened together that adheres to each part, and remains the securement medium between the parts.

6.4 BALANCED TYPE – A transformer or power supply construction with two output windings that are isolated from each other with only one end of each winding connected to ground. The construction is such that equal voltage and current is supplied to each secondary output leg and an electrical fault in one output load does not have detrimental effects on the load attached to the other output.

6.5 CLASS 2 CIRCUIT – An electrical circuit derived from a transformer, power supply, or battery source where the open-circuit voltage is less than 30 Vrms (42.4 Vpeak) or 60 Vdc with limited energy as determined by the current and VA limitations for Class 2 circuits in Article 725 of the National Electrical Code, ANSI/NFPA 70.

6.6 COLD-CATHODE SUPPLY – A transformer or power supply for cold-cathode electric discharge tubing in a cold-cathode lighting system used for general illumination in accordance with Article 410 of the National Electrical Code. Cold-cathode supplies provided with secondary ground-fault protection may also be suitable for use in signs and outline lighting systems in accordance with Article 600 of the National Electrical Code.

6.7 CONDUCTIVE CONNECTION – An electrical connection with an impedance or resistance less than a value determined by testing.

6.8 CRITICAL COMPONENT – A component that when shorted or open-circuited, adversely affects the normal operation of a circuit in a way that potentially results in an increased risk of fire or electric shock.

6.9 ELECTRIC DISCHARGE – A method of illumination in which current is passed through a gas medium. This includes neon, cold-cathode, fluorescent, and high-intensity-discharge types of illumination.

6.10 ELECTRODE-HOUSING TRANSFORMER or POWER SUPPLY – A product provided with electrode receptacles within an enclosure with no other secondary output means.

6.11 ELECTRODE RECEPTACLE – An insulating receptacle constructed of porcelain, glass, or similar material, intended to accept electrodes of neon tubing. An individual receptacle is not prohibited from being provided with an integral outer housing of metal or other material.

6.12 ENCLOSURE – A material provided to house electrical parts and components and contain a potential risk of fire. See Accessibility Barrier, 6.2, when an enclosure also serves as an accessibility barrier.

6.13 END-POINT RETURN NEON SUPPLY – A neon supply having one output winding.

6.14 FIELD-WIRING TERMINAL – A terminal connection expected to be made in the field rather than as part of a manufacturing process.

6.15 GROUNDED CONDUCTOR – A supply conductor connected to ground at the building supply source. Also known as common or neutral.

6.16 GROUNDING CONDUCTOR – A conductor provided to bond the dead-metal of a product to earth ground.

6.17 GROUND-REFERENCED NEON SUPPLY – A neon supply having the output circuit conductively connected through the chassis or to the equipment grounding means.

6.18 GTO CABLE – Gas-Tube-Oil ignition cable. A cable rated for 5, 10, or 15 kV for use between the secondary or output of a sign or oil furnace and the neon tubing or oil ignition.

6.19 GTO SLEEVING – An insulation material specifically identified for use over GTO cable. See the definition for Sleeving.

6.20 GUARD – A part provided primarily for the purpose of limiting user access to components (for example, high-temperature or moving parts) having a potential risk of injury to persons.

6.21 HIGH POWER FACTOR – A transformer construction that at rated output draws a ratio of actual (true) power to apparent power of 90% or more.

6.22 INDOOR – Describes a neon supply that is intended for indoor use only where the environmental air is controlled and conditioned within a moderate temperature range.

6.23 INDOOR WINDOW TRANSFORMER or POWER SUPPLY – A cord-connected product with secondary output leads.

6.24 ISOLATED OUTPUT NEON SUPPLY – A neon supply where the secondary or output is not conductively connected through the chassis or to the equipment grounding means.

6.25 ISOLATING BARRIER – A barrier provided to maintain separation between circuits of opposite polarity.

6.26 LUMINOUS TUBE – See definition for Neon Tube.

6.27 MID-POINT NEON SUPPLY – A neon supply having two separate outputs with one lead of each output (3-output leads or terminals) electrically connected to the other.

6.28 MID-POINT RETURN NEON SUPPLY – A mid-point neon supply provided with a return terminal or lead.

6.29 NEON POWER SUPPLY – A step-up supply source in which the high output voltage is produced primarily by electronic circuitry. The output frequency is usually greater than 60 Hz.

6.30 NEON SUPPLY – A transformer or power supply intended to supply current to the electrodes of neon tubes.

6.31 NEON TRANSFORMER – A step-up transformer of the high secondary voltage type intended to supply current to the electrodes of neon tubes.

6.32 NEON TUBE – A glass tube that emits light by passing current through one or more types of rare gas. Also known as a luminous tube.

6.33 OPEN CORE-AND-COIL TRANSFORMER – A neon transformer that has no outer covering over its coil windings that complies with enclosure requirements. This type of transformer is designated as Type 1.

6.34 OPEN HOLE – An aperture in an accessibility barrier or enclosure that is not covered or filled by another part. Typically, open holes are provided for ventilation, mounting means, and supply connections.

6.35 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. Typically, openings relate to supply connections, commonly referred to as a knockout, and accessibility for inspection of splices.

6.36 OUTDOOR – Describes a neon supply that is intended for use in outdoor applications, and shall be protected from direct contact with the weather by a building structure, sign body, or similar products and constructions. A product so located is subject to moisture by humidity or condensation or similar water vapors.

6.37 OUTPUT – The location on a transformer or power supply from which energy is capable of being drawn by a neon tubing load. On a transformer, this location is commonly referred to as the secondary.

6.38 OVERVOLTAGE CATEGORIES:

CATEGORY I – Signal Level. Low-voltage electronic logic circuits, remote controls, signaling and power limited circuits (Class 2 and similar circuits) connected to the Load Level, Category II.

CATEGORY II – Load Level. Appliances and portable equipment and similar equipment connected to the Distribution Level, Category III.

CATEGORY III – Distribution Level. Fixed wiring and associated equipment (not electrical loads) connected to the Primary Supply Level, Category IV.

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

6.39 PERFORMANCE LEVEL CATEGORY (PLC) VALUE – An integer that defines a range of test values for a given electrical/mechanical property test for polymeric (plastic) materials.

6.40 POLLUTION DEGREES:

POLLUTION DEGREE 1 – No pollution or only dry, non-conductive pollution. The pollution has no influence on conductivity.

POLLUTION DEGREE 2 – Normally only non-conductive pollution. However, temporary conductivity is capable of being caused by condensation.

POLLUTION DEGREE 3 – Conductive pollution, or dry, non-conductive pollution that becomes conductive due to condensation.

POLLUTION DEGREE 4 – Pollution that generates persistent conductivity through conductive dust, rain, or snow.

6.41 POTTED TRANSFORMER or POWER SUPPLY – A transformer or power supply in which the windings or circuitry are enclosed in a metal or polymeric container or enclosure and the void is filled with an insulating fluid that becomes solid, or remains plastic, at operating temperatures.

6.42 POWER FACTOR – The ratio of true power to apparent power. See the definition for High Power Factor.

6.43 PRESSURE-WIRE TERMINAL – A wiring terminal that accepts one or more wires for securement and for electrical connection to other conductors. This is accomplished by means of a tightening device that presses and captures a straight segment of the conductor(s) between conductive surfaces.

6.44 SECONDARY – The output voltage and energy from a winding of a neon transformer.

6.45 SECONDARY GROUND-FAULT PROTECTION – An output or secondary sensing circuit that interrupts the input or the output of the supply when a ground fault on the secondary side is sensed.

6.46 SELF-TAPPING SCREWS – Any screw that secures to a material which is not required to be pre-cut with threads to permit entrance of the screw threads. Other common names for screw types are sheet-metal, self-threading, thread-cutting, self-drilling, and thread-forming screws. See 10.4 for requirements for thread-forming screws.

6.47 SLEEVING – A covering, or an insulating or protective sheath, or both, that is intended to cover an electrical part, such as a conductor, a connection, or a splice.

6.48 SOLVENT – A material that acts as a catalyst on parts to be fastened and results in the fusing of the parts to each other, after which the material evaporates and no longer exists as a fastening medium.

6.49 SPLICE – Any point at which one wire is connected to another wire. A wire terminating at a pressure-wiring terminal or wire-binding screw is not determined to be a splice.

6.50 STRAIN RELIEF DEVICE – A knot, bushing, or others means determined to be equivalent are provided to reduce the risk of strain being transmitted to a wire or cord at a termination point inside the transformer or sign.

6.51 UNBALANCED TYPE – A transformer or power supply design with one or two output windings that are not magnetically isolated from one another (for example, one shunt for two secondary core legs). The voltage and current in each secondary output is or is not equal and an electrical fault in one output load affects the other output.

6.52 UNGROUNDED CONDUCTOR – A supply conductor that is determined as ″live″ or ″hot.″

6.53 WEATHERPROOF – Describes a neon supply that is intended to be directly exposed to the weather without an additional enclosure.

6.54 WIRE-BINDING SCREW – A screw used as a post around which a wire is to be wrapped.

CONSTRUCTION

7 Enclosures

7.1 General

7.1.1 All insulated and uninsulated current-carrying parts other than supply and output leads or terminals and the center contact of electrode receptacles shall be enclosed in metal or polymeric material in accordance with the requirements in 7.2 and 7.4.

Exception: A neon supply marked Type 1 in accordance with 47.5 is not required to be provided with an integral outer enclosure when intended to be installed in an end product having its own enclosure that complies with the Standard for Electric Signs, UL 48.

7.2 Metallic enclosure

7.2.1 A metallic enclosure shall have a metal thickness that complies with Table 7.1.

7.2.2 The values for minimum metal thickness apply to measurements made before the application of paints, varnishes, or coatings.

Table 7.1
Minimum thickness of enclosure metal

Metal	At small, flat, unreinforced surfaces and at surfaces of a shape or size to provide the required mechanical strength,		At surfaces to which a wiring system is to be connected in the field,		At large unreinforced flat surfaces,	
	in	(mm)	in	(mm)	in	(mm)
Die-cast	0.047	(1.2)	–	–	0.078	(2.0)
Cast malleable iron	0.063	(1.6)	–	–	0.094	(2.4)
Other cast metal	0.094	(2.4)	–	–	0.125	(3.2)
Uncoated sheet steel	0.026	(0.66)	0.026	(0.66)	0.026	(0.66)
Zinc-coated sheet steel	0.029	(0.74)	0.029	(0.74)	0.029	(0.74)
Nonferrous sheet metal	0.030	(0.76)	0.040	(1.02)	0.030	(0.76)

7.3 Corrosion protection

7.3.1 Except at the edge of cut ends and holes, the internal and external surfaces of an enclosure of iron or steel, other than stainless steel, or an internal surface covered with compound shall be corrosion resistant. Examples of corrosion resistance means capable of being used are galvanizing, painting, plating, and enameling or other means determined to be equivalent.

7.3.2 Laminations, and other parts of iron or steel such as washers and screws or a part that does not act as an enclosure, accessibility barrier, water shield, or a current-carrying part, are not required to be provided with corrosion protection.

7.4 Polymeric enclosure

7.4.1 An enclosure of polymeric material (thermoplastic or thermosetting) used to provide all or part of the enclosure for electrical parts as specified in 7.1.1 shall comply with the requirements in 7.4.2 – 7.4.9.

Exception No. 1: A neon supply marked Type 1 in accordance with 47.5 is not required to comply with this requirement.

Exception No. 2: When a neon supply is completely potted and the potting material complies with the enclosure requirements specified in 7.4.4, the polymeric material external to the potting shall have a minimum flammability rating of HB.

7.4.2 A material shall comply with the requirements specified in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, and as amended in this section. For permanently-connected neon supplies, the requirements for fixed equipment in UL 746C are applicable. Cord-connected neon supplies shall comply with the requirements for portable equipment in UL 746C.

7.4.3 A polymeric enclosure material shall be rated with both an electrical and a mechanical (with impact) relative temperature index in accordance with the Standard for Polymeric Materials– Short Term Property Evaluations, UL 746A, of not less than the maximum operating temperature of the enclosure material measured during the temperature test as described in the Temperature Test, Section 30.

7.4.4 For a neon supply intended for permanent connection to a source of supply, the minimum flammability rating for a neon supply enclosure shall not be less than 5 VA, and minimum V-2 for a neon supply with a detachable or non-detachable power supply cord.

7.4.5 A potting material shall have a flammability rating of minimum V-2.

Exception No. 1: A potting material that either encapsulates all insulated and uninsulated live parts or is located within a metal or polymeric enclosure complying with 7.4.4 shall have a minimum flammability rating of HB.

Exception No. 2: A potting material of the thermosetting type, such as epoxy, is not required to be tested for flammability.

7.4.6 For all neon supplies, only the HAI and CTI properties shall be applied, and the CTI and HAI PLC values shall not be greater than 2.

Exception: A thermoset material such as epoxy is not required to comply with this requirement.

7.4.7 The impact evaluation in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, shall include only the ball impact test.

7.4.8 The mold stress-relief distortion evaluation in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, shall be conducted only by the air oven method, not the test cell method.

Exception: A thermoset material such as epoxy is not required to comply with this requirement.

7.4.9 The polymeric enclosure of a neon supply marked for use in weatherproof locations shall comply with the water exposure, immersion and ultraviolet radiation exposure requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

8 Accessibility Barriers

8.1 All uninsulated or insulated current-carrying parts operating at a voltage greater than 30 Vrms (42.4 Vpeak) shall be protected against the risk of contact in accordance with 8.4 by an accessibility barrier in accordance with 8.6 during normal use, maintenance, or servicing.

Exception: A neon supply is not required to have the coil, input, and output connections made inaccessible where identified as "Exposed" in Construction Type Designation, Table 1.1, when it is marked with the intended designation type as identified in Table 1.1.

8.2 Under conditions of normal use, uninsulated current-carrying parts of a cord-connected neon supply operating at a voltage greater than 30 Vrms (42.4 Vpeak) shall be guarded in accordance with 8.3 from contact by the straight metal strip specified in 8.5.

8.3 All uninsulated current-carrying parts of a cord-connected neon supply that result in ignition of combustible materials when shorted together shall be guarded from contact in accordance with 8.1, with the straight metal strip specified in 8.5, so that a short or arc is not capable of resulting in ignition of materials.

8.4 A current-carrying part is determined to be accessible when the articulate probe shown in Figure 8.1 is capable of contacting the part. The probe shall be applied to any depth that an opening permits and with a force not greater than 1 lbf (4.4 N). The probe shall be rotated or angled before, during, and after insertion through an opening to any position that is required to examine the neon supply. The probe shall be applied in any possible configuration and, when required, the configuration is to be changed after insertion through an opening.

8.5 A current-carrying part of a cord-connected neon supply is determined to be accessible when a straight metal strip measuring 2-in (51-mm) long, 1/2-in (12.7-mm) wide, and 1/16-in (1.6-mm) thick, is capable of contacting the current-carrying part, when inserted into an opening with a force not greater than 1 lbf (4.4 N).

8.6 An accessibility barrier shall be constructed of one of the following materials:

a) Metal (ferrous, aluminum, brass, zinc, or copper), minimum 0.016-in (0.41-mm) thick;

b) Glass, porcelain, or ceramic, minimum 1/8-in (3.2-mm) thick;

c) Impregnated glass fiber sleeving minimum 0.01-in (0.25-mm) thick, that is rated for the temperature involved;

d) Vulcanized fiber, minimum 0.028-in (0.71-mm) thick;

e) A polymeric material that complies with 8.7; or

f) Mica sheet, minimum 0.016-in (0.406-mm) thick where framed by other material.

Exception: An accessibility barrier is not required to be of the minimum thickness specified when during and after the application of a force of 10 lbf (44.5 N) over an area of 1 in^2 (6.45 cm^2) to the barrier, the force applied does not result in permanent or temporary distortion, breaking, or cracking of the barrier where current-carrying parts become accessible to the probe or spacings between metal parts are less than required in Spacings, Section 24.

Figure 8.1
Articulate probe with web stop