

UL 2161

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Neon Transformers and Power Supplies

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Neon Transformers and Power Supplies, UL 2161

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Revisions: This Standard contains revisions through and including January 26, 2006.

Summary of Topics

These editorial revisions to UL 2161 replace all references to UL 1020, the Standard for Thermal Cutoffs for Use in Electrical Appliances and Components, with reference to UL 60691, the Standard for Thermal-Links – Requirements and Application Guide. UL 1020 was withdrawn and superseded by UL 60691.

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Text that has been changed in any manner 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.

The revisions dated January 26, 2006 include a reprinted title page (page1) for this Standard.

The revisions dated January 26, 2006 editorially replace all references to UL 1020 with the reference to UL 60691.

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the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing, Recognition, and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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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.

1.1 revised July 14, 1999

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.

1.2 revised March 16, 1999

1.2.1 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 20.1;
- c) Types 6, 7, and 8 neon supplies when complying with the Exception to 11.4.1 or the Exception to 11.4.3;
- d) All types of neon supplies having an isolated output when complying with Exception No. 2 to 20.1; and
- e) Cold-cathode supplies when complying with Exception No. 5 to 20.1.

1.2.1 revised July 10, 2002

1.3 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.

1.4 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 Specialty Transformers, UL 506, 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
Completely enclosed ^a	Any part exposed ^b	Wiring terminals or leads		Power supply cord	Wiring terminals or leads		Integral receptacles	Type designation number – see numbered footnotes for definition
		Exposed – not in wiring compartment or through conduit fitting	Unexposed – in wiring compartment or through conduit fitting		Exposed – not in wiring compartment or through conduit fitting	Unexposed – in wiring compartment or through conduit fitting		
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 4.1.

^b – Exposed is any current carrying part other than input and output leads or terminals that is not contained in accordance with 4.1.

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.

1.5 Deleted July 10, 2002

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, 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.

2.1.1 revised June 12, 2000

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.

2.1.2 revised June 12, 2000

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

2.1.3 revised June 12, 2000

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.

2.1.4 revised June 12, 2000

2.2 Reference publications

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

2.3 Units of measurement

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

2.3.1 revised June 12, 2000

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

2.4 Terminology

2.4.1 As used in these requirements, terms are used to refer to particular parts or features as indicated in Table 2.1.

Table 2.1
Terminology chart

Table 2.1 revised July 14, 1999

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

3 Glossary

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

3.1.1 **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, 3.1.11, when an accessibility barrier also serves as an enclosure.

3.1.2 **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.

3.1.3 **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.

3.1.4 **CLASS 2 CIRCUIT** – An electrical circuit derived from a transformer, power supply, or battery source where the open-circuit voltage is less than 30 V rms (42.4 V peak) or 60 V DC 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.

3.1.4.1 **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.

3.1.4.1 revised July 10, 2002

3.1.5 *Deleted July 14, 1999*

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

3.1.7 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.

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3.1.8 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.

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

3.1.10 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.

3.1.11 ENCLOSURE – A material provided to house electrical parts and components and contain a potential risk of fire. See Accessibility Barrier, 3.1.1, when an enclosure also serves as an accessibility barrier.

3.1.12 *Deleted March 16, 1999*

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

3.1.13 revised March 16, 1999

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

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

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

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

3.1.16.1 added March 16, 1999

3.1.17 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.

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

3.1.19 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.

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

3.1.21 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.

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

3.1.23 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.

3.1.23 revised March 16, 1999

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

3.1.25 LUMINOUS TUBE – See definition for Neon Tube.

3.1.26 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.

3.1.26 revised March 16, 1999

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

3.1.27 revised March 16, 1999

3.1.28 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.

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

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

3.1.31 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.

3.1.32 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.

3.1.33 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.

3.1.34 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.

3.1.35 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.

3.1.36 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.

3.1.37 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).

3.1.38 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.

3.1.39 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.

3.1.40 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.

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

3.1.42 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.

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

3.1.44 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.

3.1.44 revised July 14, 1999

3.1.45 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 7.4 for requirements for thread-forming screws.

3.1.46 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.

3.1.47 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.

3.1.48 **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.

3.1.49 **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.

3.1.50 **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.

3.1.51 **UNGROUNDING CONDUCTOR** – A supply conductor that is determined as "live" or "hot."

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

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

CONSTRUCTION

4 Enclosures

4.1 General

4.1.1 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 4.2 and 4.4.

Exception: A neon supply marked Type 1 in accordance with 4.3.5 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.

4.2 Metallic enclosure

4.2.1 A metallic enclosure shall have a metal thickness that complies with Table 4.1.

Table 4.1
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,	
	inch	(mm)	inch	(mm)	inch	(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

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

4.3 Corrosion protection

4.3.1 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.

4.3.2 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.

4.4 Polymeric enclosure

4.4.1 An enclosure of polymeric material (thermoplastic or thermosetting) used to provide all or part of the enclosure for electrical parts as specified in 4.1.1 shall comply with the requirements in 4.4.2 – 4.4.9.

Exception No. 1: A neon supply marked Type 1 in accordance with 4.3.5 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 4.4.4, the polymeric material external to the potting shall have a minimum flammability rating of HB.

4.4.1 revised March 16, 1999

4.4.2 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.

4.4.3 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 26.

4.4.4 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 5VA, and minimum V-2 for a neon supply with a detachable or non-detachable power supply cord.

4.4.4 revised March 16, 1999

4.4.5 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 4.4.4 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.

4.4.5 revised March 16, 1999

4.4.6 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.

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

4.4.8 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.

4.4.9 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.

5 Accessibility Barriers

5.1 All uninsulated or insulated current-carrying parts operating at a voltage greater than 30 volts rms (42.4 volts peak) shall be protected against the risk of contact in accordance with 5.4 by an accessibility barrier in accordance with 5.6 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.

5.2 Under conditions of normal use, uninsulated current-carrying parts of a cord-connected neon supply operating at a voltage greater than 30 volts rms (42.4 volts peak) shall be guarded in accordance with 5.3 from contact by the straight metal strip specified in 5.5.

5.3 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 5.1, with the straight metal strip specified in 5.5, so that a short or arc is not capable of resulting in ignition of materials.

5.4 A current-carrying part is determined to be accessible when the articulate probe shown in Figure 5.1 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 pound (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.

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

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

- a) Metal (ferrous, aluminum, brass, zinc, or copper), minimum 0.016 inch (0.41 mm) thick;
- b) Glass, porcelain, or ceramic, minimum 1/8 inch (3.2 mm) thick;
- c) Impregnated glass fiber sleeving minimum 0.01 inch (0.25 mm) thick, that is rated for the temperature involved;
- d) Vulcanized fiber, minimum 0.028 inch (0.71 mm) thick;
- e) A polymeric material that complies with 5.7; or
- f) Mica sheet, minimum 0.016 inch (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 pounds (44.5 N) over an area of 1 square inch (6.45 cm²) 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 21.

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5.7 A polymeric material used to form an accessibility barrier shall:

- a) Be rated for at least the maximum operating temperature of the barrier as measured by the Temperature Test, Section 26;
- b) Be classified at least HB in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94; and
- c) Comply with minimum property and test requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. The minimum properties are 30 seconds ignition time (maximum assigned PLC 3) for hot-wire ignition (HWI) and 60 arcs (maximum assigned PLC 1) for high-amp arc ignition (HAI). The property test requirement is the Mold Stress-Relief Distortion Test of UL 746C.

5.7 revised March 16, 1999

5.8 When an accessibility barrier is provided to protect against risk of contact with current-carrying parts exceeding 1000 volts rms (1414 V peak) to ground, the combination of the barrier material, spacing between barriers and live parts, and any other material between current-carrying parts and the user or service personnel side of the barrier shall comply with the dielectric voltage-withstand test for barrier and insulating materials as described in 27.3.1 – 27.3.5.

6 Openings and Open Holes

6.1 Open holes in an enclosure or accessibility barrier shall comply with the following:

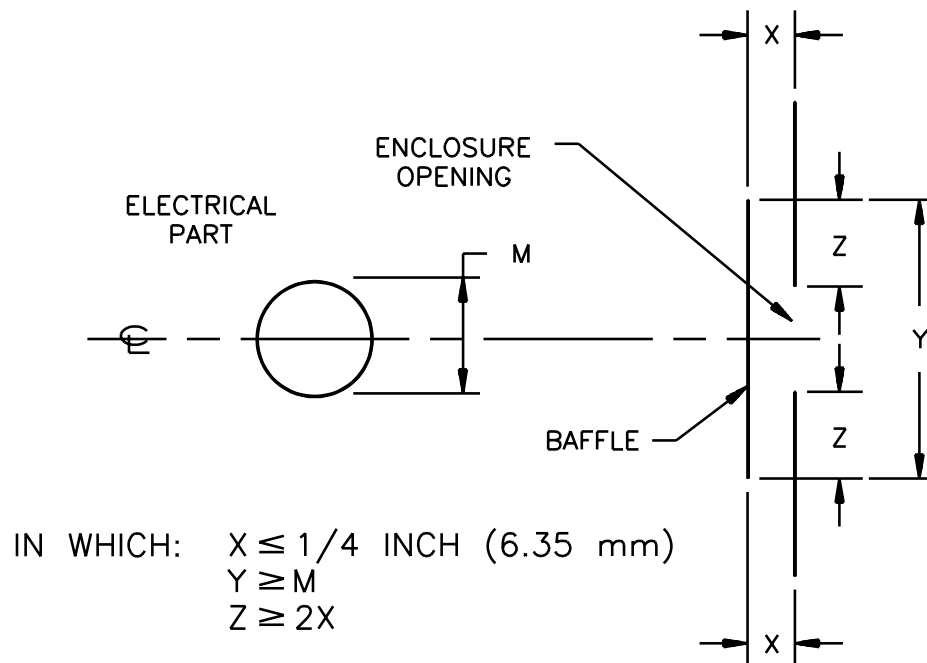
- a) The open holes shall not be larger than the dimensions specified in Table 6.1;
- b) The open holes shall not be located on a surface intended to face the material to which the neon supply is to be mounted; and
- c) The open holes comply with the accessibility requirements in Accessibility Barriers, Section 5.

Exception: An open hole that exceeds the dimensions in Table 6.1 is not prohibited when a baffle in accordance with Figure 6.1 is provided.

Table 6.1
Maximum size of miscellaneous open holes

Opening shape	Dimension,		Maximum area,		
	inch	(mm)	inches ²	(cm ²)	
Slot ^a	3/8	(width)	9.5	1-1/2	9.68
Square	1/2	(side)	12.7	—	—
Round	1/2	(diameter)	12.7	—	—
Irregular	—	—	—	1-1/2	9.68
^a An open hole between two assembled parts that does not exceed 1/32 inch (0.8 mm) is not required to comply with the area limitation.					

Figure 6.1
Relationship of baffle and electrical part to prevent emission



S3373

6.2 A cover over an open hole in an enclosure shall be provided with means (such as screws, spot welding, or similar securement methods) for firmly securing it in place. Friction alone shall not be used for this purpose.

6.3 A switch or other wiring device shall not be mounted to a cover that is required to be removed for connection of circuit conductors or servicing adjustments.

6.4 When more than one open hole is provided for supply connections or provided for output connections, all open holes shall be covered such that they exist as knockouts only.

6.5 A knockout provided over a supply or output conduit open hole shall completely cover the opening in which it is located. The knockout thickness shall comply with the requirements for enclosures. The open hole dimensions between the opening cover and the enclosure shall not exceed the maximum open hole dimension sizes as specified in Table 6.1.

6.6 A knockout shall be secured and yet removable without undue deformation of the enclosure as determined by compliance with the knockout test as described in 35.2.1 and 35.2.2.

6.7 A knockout provided in a polymeric enclosure shall comply with the Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C.

7 Securement of Parts

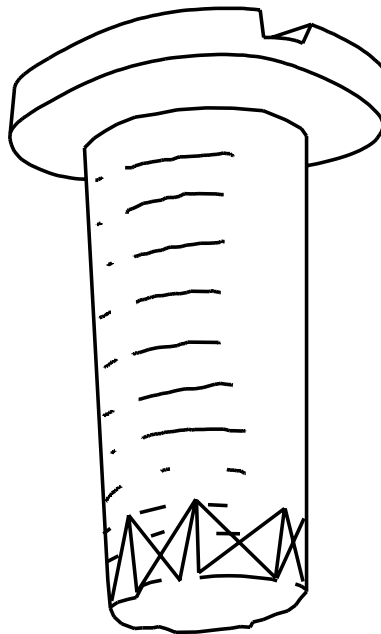
7.1 A neon supply shall be formed and assembled so that it has the strength and rigidity required to resist the abuses to which it is to be subjected, without increasing the risk of fire, electric shock, or injury to persons due to total or partial collapse which results in a reduction of spacings, loosening or displacement of parts, or other serious defects.

7.2 An adhesive (see 7.3 for a solvent) used to secure the enclosure, guard, and accessibility barrier parts together and at any other location for which the reliability of the securement means affects a potential risk of shock, shall be investigated in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.3 Securement methods that result in two or more materials being joined and fused together, such as solvent, ultrasonic welding, electromagnetic induction, and thermal welding, are not defined as adhesives and are not required to be investigated.

7.4 A thread-forming screw having criss-cross cut threads as shown in Figure 7.1 shall not be used to secure a cover or component or be utilized as a terminal type screw that is removed or replaced during field installation or servicing.

Figure 7.1
Example of thread-forming screw



S3710

8 Sharp Edges

8.1 An edge, projection, or corner of an enclosure, frame, barrier, guard, or similar parts that are accessible to contact during and after installation or as part of user maintenance and servicing shall be smooth and rounded to reduce the risk of a cut-type injury when contacted during installation, intended use, or maintenance.

9 Mounting

9.1 A neon supply shall be provided with a means of securing it to a surface to which it is to be attached. Examples of mounting means are openings in the frame and other parts.

9.2 A mounting means that relies on a polymeric material for support shall comply with the Mechanical Tests, Section 35.

10 User Accessible Controls

10.1 A user accessible control or adjustment of a neon supply shall:

- a) Be accessible without removing the enclosure and
- b) Be located where uninsulated live parts are guarded by accessibility barriers in accordance with 5.1 – 5.8.

10.2 The operation of a user accessible control or adjustment shall be included in the neon supply installation and operating instructions as specified in Instructions, Section 45.

11 Supply Connections (Does Not Include Equipment Grounding)

11.1 Permanently-connected supplies

11.1.1 A neon supply intended to be permanently connected to a source of building supply and designated as Type 3, 4, 5, or Weatherproof, shall be provided with open holes or knockouts with or without conduit fittings for supply and output connections in accordance with 11.1.2 and 11.1.3.

Exception: A neon supply intended and marked for connection only to a Class 2 circuit in accordance with 43.7 is not required to be provided with supply connection open holes or knockouts.

11.1.1 revised July 14, 1999

11.1.2 When more than one opening is provided for either a power supply connection, output connection, or both, no opening for supply or output connections shall exist as an open hole.

11.1.3 Openings for conduit shall have dimensions as indicated in Table 11.1.

Table 11.1
Conduit opening dimensions

Nominal trade size of conduit, inches (mm)		Unthreaded opening diameter ^a size, inches (mm)		Threaded opening – throat diameter				Minimum unobstructed diameter of flat surface, inches (mm)	
				Minimum, inches (mm)		Maximum, inches (mm)			
1/2	12.7	0.875	22.2	0.56	14.2	0.62	15.7	1.15	29.2
3/4	19.1	1.109	28.2	0.74	18.8	0.82	20.8	1.45	36.8
1	25.4	1.375	34.9	0.94	23.9	1.05	26.7	1.80	45.7
1-1/4	31.8	1.734	44.0	1.24	31.5	1.38	35.1	2.31	58.7

^a A plus tolerance of 0.031 inch (0.79 mm) and a minus tolerance of 0.015 inch (0.38 mm) applies to the knockout diameter. Knockout diameters are to be measured other than at points where a tab attaches the knockout.

11.1.4 An opening for the conduit shall have the dimensions as indicated in Table 11.1, and shall comply with the following:

- a) The opening shall be constructed to properly attach a conduit bushing;
- b) The minimum unobstructed diameter of the flat surface surrounding the back of a threaded or unthreaded conduit opening shall be as indicated in Table 11.1; and

Exception: A minimum unobstructed area surrounding the back of a threaded conduit opening is not required when the threads are not formed through the entire length of the hole.

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c) At least 3-1/2 to 5 threads shall be provided when the threads are not formed through the entire length of the hole, or at least 5 threads when the threads are formed through the length of the hole.

11.1.5 A field-wiring compartment provided as part of a neon supply shall be located so that the connections are accessible for inspection without disturbing wiring connections after the neon supply is installed as intended.

11.1.6 The attachment means of a field-wiring compartment shall not result in incidental rotation of the compartment.

11.1.7 A neon supply that incorporates one or more of the following supply-circuit components in which polarity is to be maintained shall have one lead or terminal identified for the connection of a grounded (neutral or common) conductor of the supply circuit:

- a) Single pole switch,
- b) Overcurrent device,
- c) Single pole interrupt component,
- d) Single pole overtemperature component, or
- e) Any other component or construction feature that relies on maintaining polarity.

11.1.8 When a field-wiring compartment is provided on a neon supply, the input and output field-wiring leads and terminals shall not occupy the same compartment.

Exception: When the input field-wiring leads and terminals are located at one end of a neon supply, and the output field-wiring leads and terminals are located at the opposite end, they are not prohibited from being located in the same neon supply enclosure when a conduit connection means is provided at each end of the enclosure.

11.2 Supply terminals

11.2.1 A field-wiring terminal shall be of the pressure-wire connector or wire-binding screw type and shall be capable of being used for connection to solid Nos. 10 AWG (5.3 mm²) – 14 AWG (2.1 mm²) conductors.

Exception: A field-wiring terminal that complies with the Standard for Wire Connectors and Soldering Lugs for Use with Copper Conductors, UL 486A, is not required to be further investigated.

11.2.2 A pressure-type wire terminal shall comply with the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

11.2.3 A wire-binding screw terminal shall either comply with the Standard for Terminal Blocks, UL 1059, or:

- a) Shall be No. 8 (4.2 mm diameter) or larger where the head of the screw and a baseplate shall cover at least three-quarters of the conductor as illustrated in Figure 11.1 and

- b) The base plate shall have a tapped hole of metal not less than 0.030 inch (0.76 mm) thick and shall not have fewer than two full threads in the metal.

Exception No. 1: A terminal plate metal of less than 0.030 inch (0.76 mm) thick is capable of being used, when a tapped hole for a screw having 32 or more threads per inch is provided and the metal extruded at the screw hole provides two full threads.

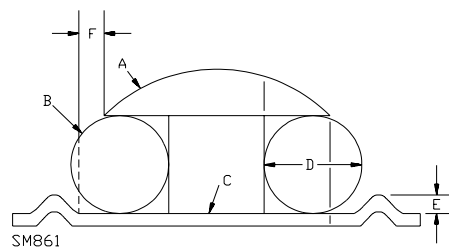
Exception No. 2: A wire-binding screw terminal is not required to comply with UL 1059 when it complies with 36.1 and 36.2.

11.2.3 revised March 16, 1999

11.2.4 A wire-binding screw and an individual stud with nut shall be provided with a means of captivating a conductor such as a cupped washer or screw having a raised ridge on the outer edge of the underside of the screw head.

Exception: A wire-binding screw that is secured in a base material that complies with 11.2.3 and Figure 11.1 is not required to be provided with additional means.

Figure 11.1
Terminal and conductor relationship



A – Wire-binding screw

B – Conductor

C – Baseplate

D – Diameter of conductor

E – Minimum height of raised area shall be 0.04 inch (1.0 mm)

F – The horizontal dimension from the edge of the screw head to the inside edge of the raised area shall be maximum 1/64 inch (0.4 mm)

11.2.5 A terminal intended for connection of a grounded supply (neutral) conductor shall be made of or plated with metal substantially white or silver in color and no other terminals shall be white or silver in color.

Exception: A terminal intended for connection of a grounded supply (neutral) conductor is not required to have a distinguishing color when marked on or adjacent to the terminal with the words "NEUTRAL," "COMMON," "N," or when the symbols "–" and "+ " are provided on the supply terminals. The lettering and symbols shall be minimum 1/4 inch (6.4 mm) high. Ink, paint, die-stamping and other similar marking means are not prohibited from being used as the marking method.

11.3 Supply leads

11.3.1 A field-wiring lead shall not be smaller than No. 18 AWG (0.82 mm²).

11.3.2 The free length of a field-wiring lead shall not be less than 6 inches (15.2 cm). Free length is measured from the point of entry of the lead into the wiring compartment to the free end of the lead.

11.3.3 The insulation of a lead intended for the connection of a grounded supply conductor (neutral or common) shall be white or natural grey and readily distinguishable from other supply leads.

11.3.4 The insulation of a lead intended for the connection of an ungrounded supply conductor (hot) shall be any color other than white, natural grey, green, or green with yellow stripe.

11.3.5 A strain relief shall be provided on field-wiring leads so that stress on a lead is not transmitted to the electrical connection inside a neon supply. The acceptability of the strain-relief means shall be determined by the Strain and Push-Back Relief Test, Section 31.

11.4 Cord- and plug-connected supplies

11.4.1 A neon supply that is not provided with means for permanent connection to a source of supply shall be provided with either a connector and detachable power supply cord or non-detachable power supply cord. The connector and supply cord shall be of the grounding (three-conductor) type.

Exception: A neon supply with no accessible dead-metal parts and evaluated only as a component for use in an end product that is determined to comply with the Standard for Electric Signs, UL 48, is not required to be provided with a supply cord of the grounding type, when marked in accordance with 44.5.

11.4.1 revised June 12, 2000

11.4.2 A power supply cord shall be minimum No. 18 AWG (0.82 mm²) and be of Type SP-2, Type SPE-2, Type SPT-2, or heavier usage.

11.4.3 A flexible supply cord shall be minimum 6 feet (1.83 m) and maximum 15 feet (4.57 m) in length as measured from the point where the cord emerges from a neon supply, or after any strain-relief means provided, to the point where the cord enters an attachment plug.

Exception: A flexible supply cord shall be permitted to be minimum 1.5 feet (0.46 m) in length, when the neon supply is only for use in wall-mounted signs and covered as a component for use in an end product that has been determined to comply with the Standard for Electric Signs, UL 48.

11.4.4 Strain and push-back relief shall be provided to reduce the risk of mechanical stress on the power supply cord from being transmitted to terminals, splices, or interior wiring. The strain-relief means shall be evaluated by the Strain and Push-Back Relief Test, Section 31.

11.4.5 Where a knot in a flexible power supply cord serves as strain relief, the surface upon which the knot contacts or bears shall not have burrs, fins, sharp edges, and projections that damage the insulation on a cord.