



UL 48

STANDARD FOR SAFETY

Electric Signs

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UL Standard for Safety for Electric Signs, UL 48

Fifteenth Edition, Dated September 2, 2011

Summary of Topics

This revision to ANSI/UL 48 dated April 22, 2022 includes the following changes in requirements:

– Relaxation of section sign markings; [7.7.1](#)

– Components for use in LED signs and changing message signs; [4.4.6.1](#), [4.3.8.1](#), [4.3.8.3](#), [4.3.8.4](#), [4.3.18.1](#), [4.3.19.3.1](#) – [4.3.19.3.3](#) and [Appendix A](#)

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

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated June 18, 2021 and April 6, 2022.

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Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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1 Scope

1.1 These requirements cover all electric signs, art forms and outline lighting for use in accordance with the National Electrical Code, NFPA 70.

1.2 Electric signs include all signs (regardless of voltage) that are electrically operated and/or electrically illuminated, including but not limited to the following methods of illumination: incandescent, fluorescent, high intensity discharge (HID), electric discharge tubing including neon tubing, light-emitting diode (LED), skeleton neon tubing, cold-cathode lamps, and electroluminescence. Unless otherwise noted the term "sign" includes signs, outline lighting, art forms, and skeleton neon tubing.

1.3 Electric signs covered by these requirements also include, but are not limited to, awning signs, trailer-mounted signs, electrically or mechanically animated signs, signs supplied by photovoltaic systems and other independent power sources, changing message signs, including scrolling, flipper, tri-view, liquid crystal display (LCD), and light-emitting diode (LED) type and other electrically operated signs that are not necessarily illuminated.

1.4 These requirements do not cover the following:

- a) Illuminated clocks operating at 600 V or less; refer to the Standard for Household Electric Clocks, UL 826 or for commercial use clocks to the Standard for Time-Indicating and -Recording Appliances, UL 863;
- b) Exit signs; refer to the Standard for Emergency Lighting and Power Equipment, UL 924;
- c) The trailer of a trailer mounted sign;
- d) Luminaires mounted to function as outline lighting; refer to the Standard for Luminaires, UL 1598;
- e) Luminaires mounted within an Awning Sign; refer to Standard for Luminaires, UL 1598;
- f) Signs that do not use electricity;
- g) Luminaires intended for billboard illumination; refer to Standard for Luminaires, UL 1598;
- h) Fiber optics or Fiber optic Illuminators;
- i) Signs for use in hazardous (classified) locations as defined in the National Electrical Code, NFPA 70.

2 Glossary

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

2.2 ACCESSIBILITY BARRIER – A material provided to limit access to the following in items (a) – (d) below. If all or part of the barrier also serves as an enclosure, see Enclosure, [2.21](#).

- a) Uninsulated live parts,
- b) Dead metal parts that are at a risk of being energized and are not grounded, and
- c) Live parts insulated with materials not intended to be subject to user contact, or
- d) Moving parts that present a risk of injury.

2.3 ACCESSIBLE PART – See Part, Accessible, [2.44](#).

2.4 ADHESIVE – Bonding material (i.e. epoxy, paste, cement) placed between parts to be fastened together that adheres to each part, and remains the securement medium between the parts.

2.5 AWNING SIGN – A fixed structure with flexible or rigid sign face material extending over a window, door, patio, walkway, etc. providing protection from the weather and integral illumination of the signage.

2.6 BARRIER – See Accessibility Barrier, [2.2](#), Heat Barrier [2.28](#), Insulating Barrier, [2.31](#), and Water Shield, [2.76](#).

2.7 BONDING – Permanent joining of metallic parts to form an electrical conductivity path that provides electrical continuity between dead metal parts and the capacity to conduct any fault current that may occur.

2.8 CANOPY – A device provided with a sign, or separately, that is used to cover an outlet box. A canopy is capable of being secured to an outlet box or to a ceiling.

2.9 CANOPY SIGN – A sign that is supported and suspended from an outlet box by a chain, stem, or cable.

2.10 CLASS 2 CIRCUIT – Wiring, conductors, and components connected only to a Class 2 supply source. See Class 2 Supply Source, [2.11](#).

2.11 CLASS 2 SUPPLY SOURCE – An electrical source such as a transformer, power supply, or battery having an open-circuit voltage that is less than 30 Vrms (42.4 Vpeak) or 60 Vdc and having limited energy available in the circuit under load conditions, including short circuit and extremely low resistance as specified by the current and VA limitations of the Article 725 of the National Electrical Code, NFPA 70.

2.12 COLD-CATHODE LAMP – An electric-discharge lamp that is characterized by an arc discharge, and in which the cathode drop is relatively high and the current density at the cathodes is relatively low.

2.13 DAMP LOCATION – See Location of Use Designation, [2.36](#).

2.14 DECORATIVE PART – A part which, if removed, does not result in the product no longer complying with the requirements.

2.15 DRY LOCATION – See Location of Use Designation, [2.36](#).

2.16 ELECTRIC DISCHARGE LIGHTING – System of illumination whereby current is passed through a gas medium. This includes neon tubing, cold cathode lamps, fluorescent, and high intensity discharge (HID) types of illumination.

2.17 ELECTRICAL EQUIPMENT – A general term including fittings, boxes, wireways, switches, receptacles, panelboards, appliances, luminaires (fixtures), and the like used as a part of an electric sign.

2.18 ELECTRODE RECEPTACLE – A contact device intended to accept electrodes of neon tubing. An individual receptacle may or may not be provided with an integral outer enclosure of metal or other material.

2.19 ELECTRODE SPLICE ENCLOSURE – Component specifically intended to enclose a splice between a GTO cable conductor and the leads of a neon tube electrode.

2.20 ELECTROLUMINESCENT – The emission of light from phosphor coatings excited by an electrostatic (capacitive) field.

2.21 ENCLOSURE – A part of the sign that encloses electrical and mechanical parts and components that involve the risk of electric shock, hazardous energy, fire, and moving parts capable of causing injury. All or part of the enclosure may also serve as a water shield, sign body, or sign face.

2.21.1 GLASS – The following are types of glass:

a) **LAMINATED GLASS** – Two or multi glass sheets bonded together, consisting of at least one glass sheet bonded to at least one other sheet of glass with an organic interlayer. When broken, cracks may appear, but the glass fragments tend to adhere to the applied organic material. See also the Standard Specification for Laminated Architectural Flat Glass, ASTM C1172.

b) **ORGANIC-COATED GLASS** – A sheet of glass covered with either an organic film or a coating. When broken, cracks may appear, but the glass fragments tend to adhere to the applied organic material.

c) **SODA-LIME GLASS** – Glass that is monolithic and based on soda-lime silicate. It can be annealed or tempered for strengthening. When broken, shards of various sizes and shapes will be released. See also the Standard Terminology of Glass and Glass Products, ASTM C162 for definition.

d) **TEMPERED GLASS** – Glass that has been treated so that when broken, it dices into fragments. See also the Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass, ASTM C1048.

2.22 GROUNDED CONDUCTOR – A system or circuit conductor intentionally connected to ground at the building supply source, also referred to as "common" or "neutral."

2.23 GROUNDING CONDUCTOR, EQUIPMENT – The conductor used to connect the non-current-carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor, the grounding electrode conductor, or both at the service equipment or at the source of a separately derived system.

2.24 GFCI (GROUND-FAULT CIRCUIT-INTERRUPTER) – A device intended to reduce the risk of electric shock by de-energizing a circuit or portion thereof within a certain amount of time after a fault to ground has been detected.

2.25 GTO CABLE – Gas-Tube-Sign Cable (formerly known as Gas Tube Oil Ignition Cable). Rated 5 kV, 10 kV, or 15 kV for use between the secondary or output of a neon supply and neon tubing and between segments of neon tubing.

2.26 GTO SLEEVING – A component specifically identified for use over GTO cable.

2.27 GTO CABLE SPLICE ENCLOSURE – Containment device intended to enclose the splice of two lengths of GTO cable that complies with the enclosure requirements.

2.28 HEAT BARRIER – A barrier provided to reduce the required spacing, or in place of the required spacing, from a heat producing component.

2.29 HID (HIGH-INTENSITY DISCHARGE) LAMP – A lamp that produces light from an electric discharge between electrodes in a gas or vapor at normal or high pressure. Common types include mercury vapor, metal halide, and high-pressure sodium lamps.

2.30 ILLUMINATION – Capable of emitting light from one of the following light sources such as Incandescent, Fluorescent, Induction Lighting, HID, Halogen, Xenon, Neon Tubing, Cold Cathode Lamp, LED, and Electroluminescent.

2.31 INSULATING BARRIER – A barrier provided in place of a required electrical spacing.

2.32 INTEGRALLY SLEEVED GTO CABLE – GTO cable that complies with the requirements for Integrally Sleeved GTO Cable in the Standard for Electric Sign Components, UL 879, and is marked "Integrally Sleeved".

2.33 LAMPHOLDER – A wiring device intended for making connection to the electrical circuits of a lamp and, in some cases, providing support.

2.34 LED (Light Emitting Diode) – A solid-state component embodying a p-n junction, emitting optical radiation when excited by an electric current.

2.35 LIVE PART – An electrically insulated or uninsulated conductive part that has a potential difference during operation with respect to ground or any other conductive part.

2.36 LOCATION OF USE DESIGNATION

a) DRY – Designation for a sign or sign component that has been evaluated for use in an environment where the component is not normally subject to dampness or wetness. Examples include inside an indoor shopping mall, inside a retail store, and other similar places.

b) DAMP – Designation for a sign or sign component that has been evaluated for use in exterior locations where protected from weather and not subject to saturation with water or other liquids, or interior locations where subject to moderate degrees of moisture, primarily by humidity and condensation. Protection overhead is generally considered to be within an area formed by an imaginary line drawn from the outer edge of the eave, overhang or sign body inward at a 45°-angle from vertical. Additionally, the interior of a sign body provided with a sign face and installed in an outdoor exposed location is considered a damp location. Examples include protected areas such as under a canopy, marquee, or a roofed porch.

c) WET – Designation of a sign or sign component that has been evaluated for use in a location that is subject to saturation with water or other liquids, such as direct spray or splashing of water or other liquids, and in unprotected locations exposed to weather.

2.37 MOBILE SIGN – A cord-connected sign that is provided with means to facilitate movement, such as being trailer mounted and does not meet one or more criteria for portable signs (e.g. size and weight limits).

2.38 NEC – National Electrical Code, NFPA 70.

2.39 NEON SUPPLY – A neon transformer or neon power supply.

2.40 NEON TUBING – Electric-discharge tubing manufactured into shapes that form letters, parts of letters, skeleton tubing, outline lighting, other decorative elements, or art forms, and filled with various inert gases.

2.41 ORDINARY TOOLS – For the purposes of these requirements, ordinary tools are defined as flat blade and Phillips head screwdrivers, nut drivers, and pliers.

2.42 OUTLET BOX – A point on a wiring system in the form of a box at which current is taken from a wiring system. Splices are made within the box.

2.43 OUTLINE LIGHTING – An arrangement of illuminated sources that outlines or calls attention to features such as the shape of a building or window.

2.44 PART, ACCESSIBLE – An electrical or moving part that is not guarded by its location or by other means and that is capable of being touched by a user during operation or user servicing.

2.45 PART, CURRENT CARRYING – An electrical part such as a wire or lampholder, that carries electrical and qualifies to be considered an insulated live part.

2.46 PART, EXPOSED LIVE – Electrical part that is accessible to a user during normal use.

2.47 PART, INSULATED LIVE – Electrical part that is energized and surrounded by insulation that is suitable for the voltage involved.

2.48 PENDANT SIGN – See Canopy Sign in [2.9](#).

2.48.1 PHOTOVOLTAIC SIGN – An off-grid/stand alone, on-grid/non-utility interactive, or utility interactive sign powered by solar energy. It may be constructed with photovoltaic modules, controls, and/or batteries integrated into a single sign cabinet or as a separate section(s) of the photovoltaic sign.

2.49 POLYMERIC MATERIAL – Materials that are thermoplastic, thermosetting, or elastomeric.

2.50 PORTABLE SIGN – A cord connected sign weighing 22.7 kg (50 lbs) or less, has a weight times length value that does not exceed 575 kg-mm (1500 lb-in) and if provided with mounting means is removable from its mounting without the use of tools.

2.51 PRESSURE WIRE CONNECTOR – A device that establishes a connection between two or more conductors or between one or more conductors and a terminal by means of mechanical pressure and without the use of solder.

2.52 QUALIFIED SERVICING – Any servicing performed by persons trained to repair and operate the equipment, and who are familiar with the risks involved. Some examples of qualified servicing include the replacing of components such as ballasts, lampholders, switches, and electric-discharge tubing. See also User Servicing, [2.75](#).

2.53 RACEWAY – An enclosed metal or nonmetallic channel, including conduit and tubing, designed for holding wires, cables, or electrical components.

2.54 RECEPTACLE – A contact device for the connection of an attachment plug.

2.55 RECESSED SIGN – A sign intended to be installed in a cavity in a wall or ceiling surface so that at least part of the sign is behind the surface.

2.56 RISK OF ELECTRIC SHOCK – A risk of electric 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-mF capacitor connected between the two points exceeds 0.5 mA_{rms} (0.7 mA_{peak}) and if the open circuit voltage exceeds 30 V_{rms} or 42.4 V_{peak} for dry, damp locations and, 15 V_{rms} or 21.2 V_{peak} for wet locations.

2.57 RISK OF FIRE – A risk of fire exists between two conductive parts if the maximum voltage, current, or VA exceeds Class 2 limits.

2.58 RISK OF INJURY – A risk of injury exists when moving parts, sharp parts, or other physically hazardous mechanical constructions are accessible.

2.59 SCREW, MACHINE – A constant diameter screw intended for threading into a nut or threaded metal material.

2.60 SCREW, SELF-DRILLING THREAD-CUTTING – A screw that drills its own hole and cuts its threads as it is installed. A common type is called a TEK screw.

2.61 SCREW, SELF-TAPPING – A screw that drills its own pilot hole and forms its own threads.

2.62 SCREW, THREAD-CUTTING – A screw that cuts its own threads in a hole into which it is screwed.

2.63 SCREW, THREAD-FORMING – A screw that forms its own threads by deforming the metal on the edges of a hole into which it is screwed.

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

2.65 SECTION SIGN – A sign shipped as subassemblies that requires field-wiring between the subassemblies to complete the overall sign.

2.66 SIGN – An electrically operated product that through illumination or mechanical means uses words, symbols, numbers, art, or other advertisement intended to convey information, attracts attention, provides information, or serves as decoration.

2.67 SIGN BODY – Portion of a sign that provides protection from the weather but is not an electrical enclosure.

2.68 SKELETON NEON TUBING – Neon tubing that is itself the sign or outline lighting and not attached to an enclosure or sign body.

2.69 SPLICE – Any point where one wire is connected to another wire. A wire terminating at a pressure wiring terminal or wire binding screw is not considered a splice.

2.70 STATIONARY SIGN – A cord-connected sign that meets all of the following:

- a) Intended to be fastened in place or located in a dedicated space;
- b) If fastened in place may be removed from its intended mounting with the use of no more than ordinary tools;
- c) Does not meet one or more criteria for portable signs (e.g. size and weight limitations); and
- d) Does not meet one or more criteria for mobile signs (e.g. provision for movement such as wheels or a trailer).

2.71 STRAIN-RELIEF – Knot, bushing, or equivalent intended to prevent strain from being transmitted through that portion of a wire or cord outside a product to the termination point of the wire or cord inside the product.

2.72 SUBASSEMBLY – Part or segment of a sign or outline lighting system that when assembled with all subassemblies forms a complete unit or product. For example, a sign subassembly is one part of an overall sign that when mechanically and electrically are assembled together form a complete sign.

2.73 TEMPERED GLASS – Glass that has been treated so that when broken, it dices into fragments not larger than 6.5 cm^2 (1 in^2), without splintering or producing sharp edges on any piece.

2.74 TRAILER SIGN – A cord connected sign intended for permanent mounting to a trailer.

2.75 USER SERVICING – Any servicing that is performed by persons other than those trained to maintain a particular sign. Replacement of neon tubing is not user servicing. Some examples of user servicing are:

- a) Attaching an accessory by means of separable connectors, or by means of an attachment plug to a dedicated receptacle.
- b) Resetting or replacing a protective device in a sign or a receptacle circuit that is overloaded by the user.
- c) Resetting a circuit breaker or replacing a fuse, automatic starter, or lamp, that is accessible without the use of a tool.
- d) Changing of advertising material and routine cleaning.

2.76 WATER SHIELD – A material relied upon to reduce the entrance of water into a sign or prevent the entrance of water onto current-carrying parts within a sign.

2.77 WET LOCATION – See Location of Use Designation, [2.36](#).

3 General

3.1 Components

3.1.1 Except as indicated in [3.1.2](#), 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 generally used in the products covered by this standard.

3.1.2 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.

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

3.2 Reference publications

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

3.3 Units of measurement

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

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

4 Construction

4.1 Mechanical

4.1.1 General

4.1.1.1 A sign shall be constructed in accordance with the requirements of [4.1](#) to have the strength and rigidity required to resist the environment to which it is subjected.

4.1.1.2 Parts of a sign that are only decorative in nature and do not affect the integrity of the sign need not comply with [4.1](#).

4.1.1.3 All parts, subassemblies, and components shall be secured to prevent loosening, unintended rotation, or turning, etc.

4.1.1.4 Moving parts of a sign or associated equipment, accessible during intended operation or user maintenance, as determined by the articulate probe in [Figure 4.3](#), and that present a risk of injury to persons must be adequately guarded or protected to prevent contact by user or operator. See [4.4.2](#) for accessibility requirements.

4.1.1.5 An edge subject to contact by wiring or other electrical components shall not be sufficiently sharp to abrade, cut, or otherwise damage electrical insulation.

4.1.1.6 An edge subject to contact by persons during normal operation or maintenance shall not be sufficiently sharp to constitute a risk of injury.

4.1.1.7 Signs not constructed in accordance with the minimum thermal spacing requirements of [4.2.3.2](#) shall comply with the Temperature Test Requirements in [5.2](#).

4.1.2 Materials

4.1.2.1 General

4.1.2.1.1 Materials used to construct signs shall comply with the appropriate requirements in [4.1.2](#).

4.1.2.2 Metal

4.1.2.2.1 Thickness

4.1.2.2.1.1 The minimum thickness of metal relied upon as an enclosure in accordance with [4.1.3](#) shall be as specified below:

- a) Cast metal shall comply with [Table 4.1](#),
- b) Sheet and extruded metals shall comply with [Table 4.2](#),
- c) Aluminum, copper, or brass shall comply with [Table 4.3](#).

Table 4.1
Thickness of cast-metal enclosures

Material or location	Minimum thickness of cast metal			
	Unreinforced		Reinforced	
	mm	(in)	mm	(in)
Cast metal	3.2	0.126	2.4	0.094
Cast malleable iron	2.4	0.094	1.6	0.063
At a threaded conduit hole	2.4	0.094	1.6	0.063
At an unthreaded conduit hole	2.0	0.079	1.2	0.047

1) Reinforced – When the material is provided with integrally cast angles, channels, ribs, flanges or ridges.

2) Threads and breakouts – Areas around threads, breakouts, or similar features, are permitted to be thinner, providing the strength of structure is not affected, but in no cast thinner than permitted for the same length of sheet metal.

Table 4.2
Minimum thickness of uncoated and zinc coated steel

Specific construction		Uncoated steel				Zinc coated or galvanized steel			
		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	0.74	0.029	0.74	0.029
Length not more than 38 cm (15 in)	No electrical component support	0.41	0.016	0.33	0.013	0.48	0.019	0.41	0.016
	Electrical component support	0.41	0.016	0.41	0.016	0.48	0.019	0.48	0.019
Length more than 38 cm (15 in) and less than 66 cm (26 in)	No electrical component support	0.41	0.016	0.33	0.013	0.48	0.019	0.48	0.019
	Electrical component support	0.51	0.020	0.41	0.016	0.58	0.023	0.48	0.019
Length 66 cm (26 in) and greater	No electrical component support	0.51	0.020	0.41	0.016	0.58	0.023	0.48	0.019
	Electrical component support	0.66	0.026	0.51	0.020	0.74	0.029	0.58	0.023

- 1) Length – the longest straight line that can be drawn on any unsupported section of an enclosure. The longest straight line is measured in any direction regardless of the shape of the enclosure section in any direction. The longest straight line for an enclosure section that is frame supported in accordance with [4.1.2.2.1.6](#) and [4.1.2.2.1.7](#) is measured in any direction on the enclosure panel between the frame supporting members.
- 2) Length and Frame supported – A section of an enclosure secured to framing members not integral to the enclosure panel in accordance with [4.1.2.2.1.6](#) and [4.1.2.2.1.7](#).
- 3) Unreinforced – A section of an enclosure as described in [4.1.2.2.1.3](#) or that does not comply with the requirements in [4.1.2.2.1.2](#) and [4.1.2.2.1.4](#) for being a reinforced enclosure section.
- 4) Reinforced – A section of an enclosure that is provided with curves, ribs, breaks or flanged surfaces in accordance with [4.1.2.2.1.2](#) and [4.1.2.2.1.4](#).
- 5) No electrical component support – the minimum thickness required when no electrically components are secured to and supported by the enclosure surface.

Table 4.3
Minimum thickness of aluminum, copper, or brass enclosures

Specific construction		Copper, brass, aluminum sheet and extruded aluminum			
		Unreinforced		Reinforced	
		mm	(in)	mm	(in)
At opening for conduit connection		0.81	0.032	0.81	0.032
Length not more than 38 cm (15 in)	No electrical component support	0.51	0.020	0.51	0.020
	Electrical component support	0.51	0.020	0.51	0.020
Length more than 38 cm (15 in) and less than 66 cm (26 in)	No electrical component support	0.51	0.020	0.51	0.020
	Electrical component support	0.64	0.025	0.51	0.020
Length 66 cm (26 in) and greater	No electrical component support	0.56	0.022	0.51	0.020
	Electrical component support	0.71	0.028	0.56	0.022
1) Length – the longest straight line that can be drawn on any unsupported section of an enclosure. The longest straight line is measured in any direction regardless of the shape of the enclosure section in any direction. The longest straight line for an enclosure section that is frame supported in accordance with 4.1.2.2.1.6 and 4.1.2.2.1.7 is measured in any direction on the enclosure panel between the frame supporting members. 2) Length and Frame supported – A section of an enclosure secured to framing members not integral to the enclosure panel in accordance with 4.1.2.2.1.6 and 4.1.2.2.1.7. 3) Unreinforced – A section of an enclosure as described in 4.1.2.2.1.3 or that does not comply with the requirements in 4.1.2.2.1.2 and 4.1.2.2.1.4 for being a reinforced enclosure section. 4) Reinforced – A section of an enclosure that is provided with curves, ribs, breaks or flanged surfaces in accordance with 4.1.2.2.1.2 and 4.1.2.2.1.4. 5) No electrical component support – the minimum thickness required when no electrically components are secured to and supported by the enclosure surface.					

4.1.2.2.1.2 A reinforced construction as indicated in [Table 4.1](#), [Table 4.2](#), and [Table 4.3](#), is an enclosure material provided with integral angles, channels, breaks, ribs, flanges or ridges, that provides a mechanical strength across the span of the material. The reinforcement feature shall divide the enclosure into sections such that the longest dimension of all of the resulting sections is one third or less than the longest dimension of the undivided enclosure:

- a) Flanges, angles or breaks that are 45° to 120° to the plane of the panel,
- b) Ribs and ridges that are at least 3.2-mm (0.126-in) high from the plane of the panel with an internal angle of 45° to 120°,
- c) Curves running across the shortest dimension, or
- d) Channels having two 90° angles or breaks running in any direction.

4.1.2.2.1.3 The following constructions are not considered to be reinforced:

- a) A single sheet with a formed edge flange around its perimeter,
- b) A single sheet that is ribbed not meeting the angle criteria in [4.1.2.2.1.2](#),
- c) A single sheet that is corrugated with the curves running parallel to the long dimension, and

d) A single sheet of sheet metal with reinforcement features, but secured to a peripheral frame by a means that would allow the material to flex at its center. For example, securement by physical fit into a channel.

4.1.2.2.1.4 For a cast metal to be considered as reinforced as specified in [Table 4.1](#), the material must be provided with integrally cast angles, channels, ribs, flanges or ridges.

4.1.2.2.1.5 The length dimensions specified in [Table 4.1](#), [Table 4.2](#) and [Table 4.3](#) are measured as the longest straight line that can be drawn across any unsupported section of the material. The longest straight line for an enclosure section is measured in any direction regardless of the shape. The longest straight line for an enclosure section that has a supporting frame in accordance with [4.1.2.2.1.6](#), is measured in any direction on the enclosure panel between the supporting frame members.

4.1.2.2.1.6 A supporting frame is a structure of angle, channel or a rigid folded length of sheet metal that is not an integral part of the enclosure panel and complies with [4.1.2.2.1.7](#). The supporting frame must be rigidly attached to the enclosure material at regular intervals and to other materials to which the enclosure material is secured, and have essentially the same outside dimensions as the enclosure surface.

4.1.2.2.1.7 A supporting frame shall consist of:

- a) Steel or aluminum angle having a cross sectional dimension of at least 13 by 13 mm (0.5 by 0.5 in) with a minimum material thickness of 3.2 mm (0.125 in);
- b) Flat metal bars which are minimum 9.5-mm (0.375-in) wide and 3.2-mm (0.125-in) thick; or
- c) An internal metal structure such as a chassis, that is rigidly secured together to form a 3 dimensional structure onto which the enclosure material is secured at regular intervals.

4.1.2.2.2 Metal corrosion protection

4.1.2.2.2.1 Except as noted in [4.1.2.2.2.2](#), all surfaces of ferrous metal parts including hinges, bolts and fasteners, other than parts specified in [4.1.2.2.2.2](#), shall be protected against corrosion by galvanizing, painting, plating, corrosion resistant coating or enamel.

4.1.2.2.2.2 The following ferrous metal parts need not be protected against corrosion:

- a) Punched holes and cut edges of sheet metal;
- b) Edges, punched holes, and spot welds of pre-finished steel;
- c) Enclosed steel pipe and hanger locations for painting and plating;
- d) Shafts, bearings, sliding surfaces of a hinge, hinge pins, and other parts whose intended operation are adversely affected by plating or coating, and all parts that, in their intended operation, will be oil or grease coated;
- e) Corrosion resistant ferrous metals such as stainless steel; or
- f) Where the two surfaces of an identical ferrous alloy are in permanent contact.

4.1.2.2.2.3 Ferrous metal surfaces shall be prepared prior to painting, coating, or plating. The manufacturer shall have a system in place to ensure the surface is clean and free of contaminants.

4.1.2.3 Polymeric material

4.1.2.3.1 A polymeric material that functions as an enclosure, an accessibility barrier to reduce the risk of electric shock or mechanical injury, or that portion of a sign body located above live parts that diverts water from contacting those live parts shall comply with the requirements in the Standard for Electric Sign Components, UL 879, applicable for its intended function and rating.

4.1.2.3.2 A polymeric material shall be spaced away from heat producing components in accordance with the thermal spacing requirements of [4.2.3.2](#).

4.1.2.4 Other materials

4.1.2.4.1 A material other than metal, glass, or polymeric, that is of an inorganic composition such as ceramic and porcelain, shall comply with the requirements in the Standard for Electric Sign Components, UL 879, the enclosure requirements in [4.1.3](#), and accessibility requirements of [4.2.2](#).

4.1.2.5 Gaskets

4.1.2.5.1 A gasket used to seal a joint so that a sign complies with the Exclusion of Water requirements in [5.9](#) shall be constructed of neoprene, rubber, neoprene-composition, rubber-composition, synthetic rubber, or similar material that complies with one of the following:

- a) Investigated and found suitable for use as a weather seal in outdoor or wet location signs, luminaires, industrial control panels, or similar outdoor or wet location electrical equipment, or
- b) Complies with the Gasket Aging Test in [5.7](#).

4.1.2.5.2 The gasket shall be secured so that it does not loosen from the mounting means.

4.1.2.5.3 The gasket of a gasketed joint that must be opened in order to relamp or change advertising material shall be secured in place by:

- a) Rivets, screws, or similar mechanical means, or
- b) Comply with the Gasket Adhesion Test described in [5.8](#).

4.1.2.5.4 The gasket and securement of the gasket shall not be damaged when the joint is opened.

4.1.3 Enclosures

4.1.3.1 General

4.1.3.1.1 An enclosure shall consist of one or more fabricated and/or prefabricated enclosures constructed in accordance with the requirements of [4.1.3](#).

4.1.3.1.2 Enclosure parts shall be secured by positive mechanical means, such as screws or welding.

4.1.3.1.3 The tolerance of fit between parts of wire ways or the sign enclosure shall not exceed 3.2 mm (0.127 in) in width. A 6.4-mm (0.25-in) tolerance is allowed in a raceway which circumferences the pole in a pole mounted sign.

4.1.3.2 Fabricated enclosures

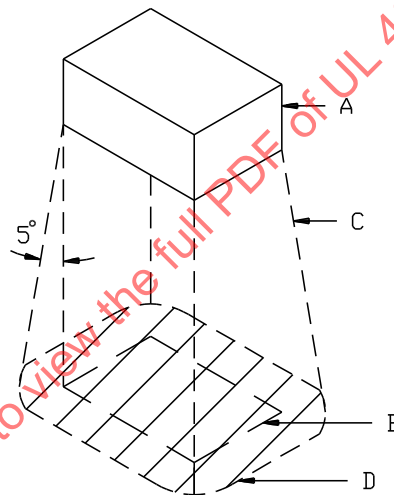
4.1.3.2.1 General

4.1.3.2.1.1 Metal enclosures shall comply with requirements of [Table 4.1](#), [Table 4.2](#), and [Table 4.3](#).

4.1.3.2.2 Openings in fabricated enclosures

4.1.3.2.2.1 Openings shall not be located in the mounting surface, a canopy, or directly below electrical parts unless baffled in accordance with [Figure 4.1](#).

Figure 4.1
Location of baffle – directly below



Notes:

- A – Electrical component to be shielded by the barrier.
- B – Projection of the component outline on a horizontal plane.
- C – Inclined, 5 degree line, indicating minimum perimeter of the barrier.
- D – Minimum area of the barrier.

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4.1.3.2.2.2 If provided with openings, an enclosure housing open core and coil devices (e.g. Type 1 neon supply/transformers, open motors, and the like) shall comply with one of the following:

- a) The openings are baffled per [Figure 4.1](#), or
- b) Openings oriented horizontally or above relative to the coil device mounting and are spaced a minimum of 15.2 cm (6 in) from the coil device.

4.1.3.2.2.3 A cover over an open hole in an enclosure shall be provided with means (such as screws, spot welding, interlock tangs and the like) to firmly secure it in place. Friction alone is not considered sufficient.

4.1.3.2.2.4 A knockout shall be adequately secured and yet removable without undue deformation of the enclosure as determined by compliance with [5.18](#), Conduit Knockout and Twist Out Test.

4.1.3.2.2.5 A switch or other wiring device shall not be mounted to a cover that must be removed to permit the connection of circuit conductors or servicing adjustments.

4.1.3.2.2.6 If more than one open hole is provided for the supply and output connections, all but one of the open holes shall be covered such that they exist as either knockouts or covered open holes.

4.1.3.2.2.7 A knockout provided over a supply or output conduit open hole shall completely cover the opening in which it is located and the clearance between the cover and the opening shall be no more than 0.25 mm (0.010 in) before painting. The knockout thickness shall comply with the enclosure requirements.

4.1.3.2.2.8 If provisions for conduit connection are made directly to a polymeric enclosure, sign body, or other polymeric sign part, the part shall comply with all applicable requirements for that part and [5.17](#), Torque, Bending moment, and Conduit Pullout Test.

4.1.3.2.3 Drain openings

4.1.3.2.3.1 Except as noted in [4.1.3.2.3.2](#) and [4.1.3.2.3.8](#), the sign body and/or fabricated enclosure of a sign intended for installation in a damp or wet location shall be provided with drain openings that comply with the requirements of [4.1.3.2.3](#).

4.1.3.2.3.2 A sign body of a sign without a sign face or a sign body otherwise designed such that it is not capable of retaining water is not required to have drain openings.

4.1.3.2.3.3 The drain opening shall be located on the bottom or bottom edge of the back surface in an area free from obstructions that would affect drainage through the opening.

4.1.3.2.3.4 The drain opening shall be free from burrs and either circular having a diameter of 6.4 – 12.7 mm (0.25 – 0.50 in) or non-circular with the smallest dimension at least 6.4 mm (0.25 in) and an area of 32.3 – 129 mm² (0.05 – 0.20 in²)

4.1.3.2.3.5 When a drain opening is located at the bottom edge of the back surface of a wall mounted sign, the opening shall be at least 12.7 mm (0.50 in) from the mounting surface of the sign or the installation instructions provided with the sign shall indicate that a minimum of 12.7-mm (0.50-in) clearance should be maintained between the drain openings and the mounting surface.

4.1.3.2.3.6 Drain openings shall be located at all of the following locations applicable for signs and internal raceways (see [Figure 4.2](#)):

- a) The bottom of each of the lowest points of the sign,
- b) At least one in each isolated section and at least every 1.22 m (4 ft) in each isolated section,
- c) Both sides of the pole for a pole mounted sign, and
- d) Horizontal troughs or retainers for supporting sign faces, panels, or letters.

Figure 4.2
Example of drain hole placement



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4.1.3.2.3.7 A barrier provided to block light from exiting the sign through a drain opening shall be spaced minimum 6.4 mm (0.25 in) from the surface provided with the drain opening.

4.1.3.2.3.8 Signs intended for installation in damp or wet locations need not comply with the drain opening requirements of [4.1.3.2.3](#) provided that they comply with either:

- a) The requirements for a Type 3R or better enclosures as defined in the Standard for Enclosures for Electrical Equipment, Non-Environmental Considerations, UL 50; or
- b) The Rain Test described in 3.4.1.9 in the Standard for Electric Sign Components, UL 879 where there is no indication of water entering the units.

4.1.3.2.3.9 Screens or mesh covering a drain opening is permitted when:

- a) The screens or mesh are accessible for periodic inspection; and
- b) Markings are provided per [7.2.18](#) and [8.1.7](#).

4.1.3.2.4 Ventilating openings

4.1.3.2.4.1 Ventilating openings shall not affect the strength and rigidity of a sign.

4.1.3.2.4.2 An enclosure that is not integral to a ballast, transformer, neon transformer or power supply, motor, clock motor, or other similar part shall:

a) Have no ventilating openings when the ballast, transformer, motor, clock motor, or similar product is an open core-and-coil device or is a neon transformer or power supply with a Type 1 designation, or

b) Have no ventilating openings on the bottom surface directly under the ballast, transformer, motor, or clock motor or other similar parts that has a coil having its own enclosure (enclosed) or is a neon transformer or power supply with other than a Type 1 designation. The surface identified as the bottom shall be determined with the enclosure in the intended installation orientation.

4.1.3.2.4.3 A ventilating opening may be provided in a sign body if the construction complies with [5.9](#), the Exclusion of Water Test.

4.1.3.2.4.4 Except as noted in [4.1.3.2.4.5](#), a ventilating opening shall be covered by screening, expanded metal, or other equivalent means when the opening is a slot or louver more than 9.5-mm (3/8-in) wide or more than 9.68 cm² (1.50 in²) in area, or when any other ventilating opening is more than 12.7 mm (0.50 inch) in diameter or 1.61 cm² (0.25 in²) in area. An opening in the screening or expanded metal, or other equivalent means shall not permit the passage of a rod having a diameter larger than 12.7 mm (0.50 in).

4.1.3.2.4.5 A screening, expanded metal, or equivalent covering is not required when the opening does not permit the entrance of a 12.7 mm (0.50 in) diameter rod and baffles or overlapping sections of the enclosure, changes in the direction of the path through the opening, orientation of the path, or other means are provided to reduce the likelihood of debris entering the enclosure.

4.1.3.3 Prefabricated enclosures

4.1.3.3.1 The conduit, tubing, and cable specified in [Table 4.4](#) are considered enclosures or enclosed.

Table 4.4
Conduits and Cables used as enclosures or considered enclosed

Conduit/cable type	Intended location			Uses permitted			
	Dry	Damp	Wet	To enclose conductors 1000 V or less	To enclose GTO	Minimum Trade size	Special Notes
Flexible Metallic Tubing (FMT)	A	No	No	A	No	1/2, 16	c)
Flexible Metal Conduit (FMC)	A	A	A ^{e)}	A	A	1/2, 16	b)
Electrical Metallic Tubing (EMT)	A	A	A	A	A	1/2, 16	
Liquid-tight Flexible Metal conduit (LFMC)	A	A	A	A	A	1/2, 16	b)
Liquid-tight Flexible Nonmetallic Conduit (LFNMC)	A	A	A	A	A	1/2, 16	a), b)
Intermediate Metal Conduit (IMC)	A	A	A	A	A	1/2, 16	
Rigid Metal Conduit (RMC)	A	A	A	A	A	1/2, 16	
Rigid Nonmetallic Conduit (RNC)	A	A	A	A	A	1/2, 16	a)
Armored Cable (AC)	A	A ^{d)}	A ^{d)}	A 600 V max	NA	NA	a)
Metal-clad Cable (MC)	A	A ^{d)}	A ^{d)}	A	NA	NA	
A – Acceptable as an enclosure or is considered enclosed							
NO – Cannot be used as an enclosure or is not considered enclosed							

Table 4.4 Continued on Next Page

Table 4.4 Continued

Conduit/cable type	Intended location			Uses permitted			
	Dry	Damp	Wet	To enclose conductors 1000 V or less	To enclose GTO	Minimum Trade size	Special Notes
NA – Not Applicable a) Sunlight resistant only b) Factory installed wiring that is internal to a sign body or enclosure that operates at no more than 1000 V can be installed in 9.5 mm (3/8 in) trade size flexible conduit or tubing with maximum 1.83-m (6-ft) length. c) 1.83 m (6 ft) maximum length d) Must be marked for such use (plastic Jacketed) e) Acceptable for use in wet locations only if located or oriented so that contact with water does not occur as a result of the Exclusion of Water Test in 5.9 .							

4.1.3.3.2 Electrical equipment not suitable for wet locations shall be located or oriented so that contact with water does not occur as a result of the Exclusion of Water Test in [5.9](#).

4.1.3.3.3 The conduit, tubing, and cable indicated in [Table 4.4](#) shall be supported at intervals not greater than those specified in [Table 4.5](#).

Table 4.5
Maximum distance between supports for conduit, tubing, and cable

Type	Distance	
	m	(ft)
Flexible Metallic Tubing (FMT)	0.91	(3)
Flexible Metal Conduit (FMC)	1.37	(4.5)
Electrical Metallic Tubing (EMT)	3.05	(10)
Liquid-tight Flexible Metal Conduit (LFMC)	1.37	(4.5)
Liquid-tight Flexible Nonmetallic Conduit (LFNMC)	1.37	(4.5)
Intermediate Metal Conduit (IMC)	3.05	(10)
Rigid Metal Conduit (RMC)	3.05	(10)
Rigid Nonmetallic Conduit (RNC)	0.91	(3)
Armored Cable (AC)	1.37	(4.5)
Metal-clad Cable (MC)	1.83	(6)
Class 2 cable, CL2, CL3, PLTC or permitted substitution	1.83	(6)

4.1.3.3.4 Cut ends of metal conduit shall be deburred or provided with bushings.

4.1.3.3.5 Flexible metal conduit shall not be painted or similarly coated with any material unless all the following conditions are met:

- a) The flexible metal conduit is not relied upon for grounding or bonding;
- b) The flexible metal conduit is inside the sign body; and
- c) The flexible metal conduit is installed and secured in place and not subject to movement during normal user servicing such as lamp replacement.

4.1.4 Sign bodies

4.1.4.1 General

4.1.4.1.1 For a sign body constructed of glass see Supplementary Requirements, [4.4](#).

4.1.4.1.2 A sign body that encloses insulated or uninsulated live parts shall comply with the enclosure requirements of [4.1](#).

4.1.4.1.3 A polymeric sign body, other than the face, shall comply with the applicable requirements of the Standard for Electric Sign Components, UL 879.

4.1.4.1.4 Unless internal barriers, other internal sign body parts, enclosures, and the like of a wet location sign prevent water from contacting insulated and uninsulated live parts that are not identified for use in contact with water, the sign body shall prevent water from contacting the designated parts.

4.1.4.1.5 A sign body shall be secured by positive mechanical means, such as screws or welding.

4.1.4.1.6 Access covers located on the top or side of a wet location sign body shall have mechanical provisions or gaskets to prevent the intrusion of water.

4.1.4.2 Faces

4.1.4.2.1 A sign face or multiple section face shall be secured such that during normal movement of the face the sign shall comply with [5.9](#), Exclusion of Water Test.

4.1.4.2.2 A means such as a barrier, securement, or equivalent shall be provided so that the movement of the sign face does not reduce spacings below the minimum required to a live part or heat producing component as specified in [4.2.3](#).

4.1.4.2.3 A rigid polymeric sign face shall not be relied upon to support electrical components such as through wall housings, conduit connections, and the like unless the sign face complies with the applicable requirements in the Standard for Electric Sign Components, UL 879.

4.1.4.2.4 A flexible sign face shall comply with the applicable requirements of the Standard for Electric Sign Components, UL 879.

4.1.4.3 Openings in sign bodies

4.1.4.3.1 Openings in a sign body shall comply with [5.9](#), the Exclusion of Water Test.

4.1.4.3.2 Openings in a sign body shall comply with [4.2.2](#), accessibility to live parts.

4.1.4.3.3 Exterior-use, non-hardening sealant may be used to seal an opening in a sign body acting as a water shield if used in a location where it is not disturbed during relamping, changing copy, or other similar user functions.

4.1.5 Fastening methods

4.1.5.1 General

4.1.5.1.1 Materials, equipment and products in signs must be constructed to:

- a) Provide strength and rigidity and prevent movement that would result in a failure of the sign to comply with the requirements of this standard, and
- b) Avoid damage to conductors or electrical equipment.

4.1.5.1.2 Each joint and edge in metal, thermoplastics and other materials shall be fastened or secured in place, such as by welds, solder, rivets, adhesives, formed joints, retaining troughs, retaining clips, hinges, bolts, or screws, to complete an assembly constructed for its intended use.

4.1.5.1.3 Other fastening methods and spacings may be used if found to provide adequate strength, rigidity, and reliability.

4.1.5.2 Spacings of fastenings

4.1.5.2.1 In a sign, the spacing of fastenings shall be:

- a) Continuous for formed joints, retaining troughs, solder and adhesive;
- b) No greater than the following:
 - 1) For mechanical fasteners 205 mm (8 in) for metal less than 0.79-mm (0.031-in) thick;
 - 2) For mechanical fasteners 305 mm (12 in) for metal at least 0.79-mm (0.031-in) thick, and less than 1.27-mm (0.050-in) thick;
 - 3) For mechanical fasteners 305 mm (12 in) for metal less than 0.79-mm (0.031-in) thick and mounted on a structural framework;
 - 4) For mechanical fasteners 610 mm (24 in) for metal 1.27-mm (0.050-in) thick or more; and
 - 5) For mechanical fasteners 610 mm (24 in) for metal at least 0.79 mm (0.031 in) and less than 1.27-mm (0.050-in) thick when the metal is mounted on a structural framework.
- c) Noncontinuous clamping or tensioning system for flexible material provided it meets the following:
 - 1) The system will not tear the flexible material;
 - 2) Flexing of the face does not result in a failure of the Exclusion of Water Test;
 - 3) Flexing of the face does not result in a failure to maintain the minimum Temperature Spacing requirements; and
 - 4) Flexing of the face does not touch or damage internal components.
- d) Other minimum spacings or spacing configurations that have been evaluated and found to provide equivalent mechanical security.

4.1.5.2.2 A support clip or trough of material other than metal may be used if investigated and found acceptable.

4.1.5.2.3 A polymeric support clip or trough relied upon to retain a sign face in position shall comply with the Standard for Electric Sign Components, UL 879, and be identified for the use.

4.1.5.3 Screws

4.1.5.3.1 Screws used to secure sign parts to polymeric materials or to sheet aluminum, copper, or aluminum- or copper-base alloys of less than 1.27-mm (0.050-in) thickness shall be tightened in accordance with fastener manufacturer's securement and/or torque recommendations such that they do not strip or pull out.

4.1.5.3.2 Screws, other than machine screws and nuts, relied upon to support a part weighing 3.4 kg (7.5 lbs) or more per screw shall comply with [5.20](#), Self-threading Screw Torque Test.

4.1.5.3.3 Except as noted in [4.1.5.3.4](#), self-drilling thread cutting and thread-forming screws shall not be used to secure a door, cover, or component, or be utilized as a terminal type screw that will be removed or replaced during field servicing.

4.1.5.3.4 Self-drilling thread cutting and thread forming screws are not prohibited from use in signs to secure panels, covers, sign or channel letter faces, or components if they are not likely to be removed or replaced during user servicing or routine maintenance such as lamp replacement.

4.1.5.4 Adhesives and sealants

4.1.5.4.1 Adhesives shall be rated for the surfaces and under the conditions of use in accordance with the Standard for Electric Sign Components, UL 879.

4.1.5.4.2 Silicone room temperature vulcanizing (RTV) used for mechanical securement shall comply with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, requirements for adhesives.

4.1.5.5 Solvents and sonic welding

4.1.5.5.1 Solvent, ultrasonic welding, electromagnetic induction, and thermal welding are acceptable means of securement.

4.1.5.5.2 Plastic parts are considered secured to other plastic parts when the joint is made by a continuous solvent bond using solvent cement or ultrasonic welding means. Other types of adhesive shall be evaluated for the type of material, environment, and service temperature in accordance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

4.1.6 Sign mounting and support

4.1.6.1 Permanently connected signs

4.1.6.1.1 Permanently connected signs or sections shall be provided with means of permanent attachment to a support structure or building, such as mounting holes, fasteners, brackets, or instructions that identify locations on the sign body structurally suitable to support the sign with the acceptable fastening methods at those locations.

4.1.6.1.2 Each section of a permanently connected section sign designed to directly attach to another section shall be provided with means for such attachment.

4.1.6.2 Portable signs

4.1.6.2.1 Except as noted in [4.1.6.2.4](#), a portable sign shall not have any provision for being permanently mounted.

4.1.6.2.2 Except as noted in [4.1.6.2.4](#), a portable sign provided with mounting means shall be removable without the use of tools.

4.1.6.2.3 A portable sign provided with mounting means shall comply with [5.6](#), the mounting means test.

4.1.6.2.4 A portable sign that is intended to be mounted to a cord connected appliance, such as a refrigerated cabinet, vending machine, automatic teller machine (ATM), or similar appliance, or mounted on portable, non-electrical display equipment or store display may have provisions for being permanently mounted.

4.1.6.2.5 A free-standing type sign shall comply with [5.5](#), the stability test.

4.1.6.2.6 A portable hanging type sign shall be provided with hanging means and shall not be provided with open mounting holes in the sign body.

4.1.6.2.7 A portable wall mount sign shall be provided with a concealed keyhole slot, a notch, or a hanger hole such that when the sign is mounted in position on a wall the mounting hardware is inaccessible to the installer and prevented from being tightened. Keyhole slots open to the front of the sign are not permitted.

4.1.6.2.8 If a keyhole slot or notch is provided in the enclosure of a sign, it shall be located such that the supporting screw or similar mounting hardware does not contact any uninsulated parts of the sign.

4.1.6.3 Stationary signs

4.1.6.3.1 A stationary sign shall not have any provision for being permanently mounted.

4.1.6.3.2 If provided with mounting means, the sign shall be removable without disassembly.

4.1.6.3.3 If provided with mounting means, the sign shall comply with [5.6](#), the mounting test.

4.1.6.3.4 Free-standing stationary signs shall comply with [5.5](#), the stability test.

4.1.6.3.5 A stationary hanging type sign shall be provided with the hanging means and shall not be provided with open mounting holes in the sign body.

4.1.6.4 Mobile signs

4.1.6.4.1 Mobile signs shall be provided with mounting hardware for the specified trailer.

4.2 Electrical

4.2.1 General

4.2.1.1 The following requirements apply to electrical components, wiring, spacing, accessibility and other related electrical requirements and are in addition to other enclosure and construction requirements in [4.1](#).

4.2.2 Accessibility to live parts

4.2.2.1 General

4.2.2.1.1 Except as noted in [4.2.2.1.2](#) and [4.2.2.1.3](#) contact with all uninsulated current-carrying parts shall be prevented by an enclosure or barrier.

4.2.2.1.2 An uninsulated live part connected to the secondary of a Class 2 circuit may be accessible in signs intended for use in a dry location.

4.2.2.1.3 An uninsulated live part connected to the secondary of a Class 2 circuit not exceeding 15 Vac rms and 30 Vdc may be accessible in signs intended for installation in a dry, damp or wet location.

4.2.2.1.4 Live parts of an electrical device, such as a lampholder or starter holder, may be accessible only during user maintenance.

4.2.2.1.5 A sign that is intended to have the lamps replaceable without opening the enclosure shall be constructed so that live parts and live connections are not exposed to unintentional contact while lamps are being replaced.

4.2.2.1.6 An integral raceway or compartment provided to allow branch circuit(s) or feeder conductor(s) to pass through a sign body or enclosure without supplying any circuits of the sign shall be constructed such that the through wiring will not become accessible during sign servicing.

4.2.2.2 Uninsulated parts

4.2.2.2.1 Except as noted in [4.2.2.1](#) and [4.2.2.2.2](#), all uninsulated live parts shall be inaccessible during normal use and user servicing, including lamp replacement. Accessibility is determined by use of the articulate probes in [Figure 4.3](#) and [Figure 4.4](#).

Figure 4.3
Articulate probe with web stop

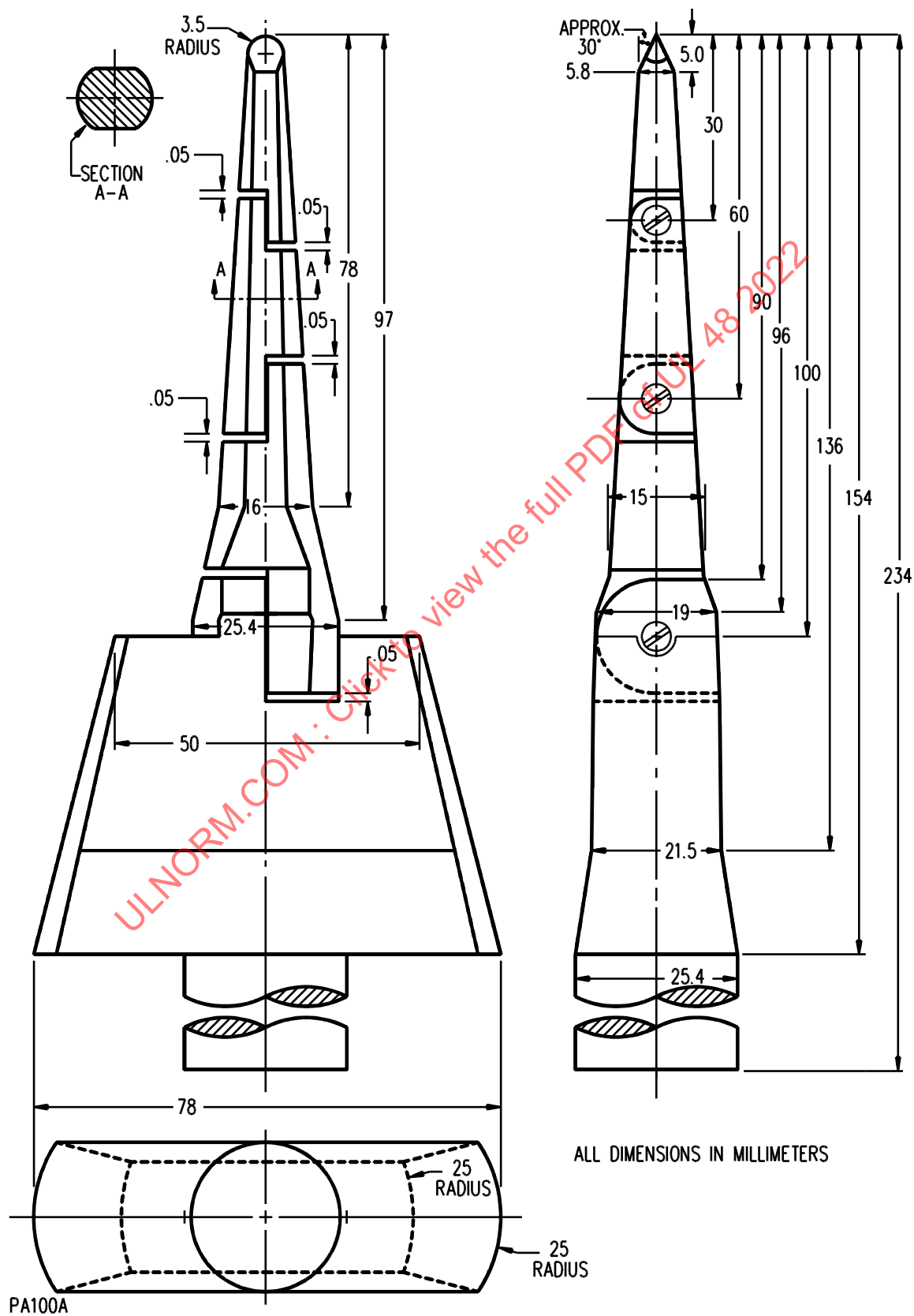
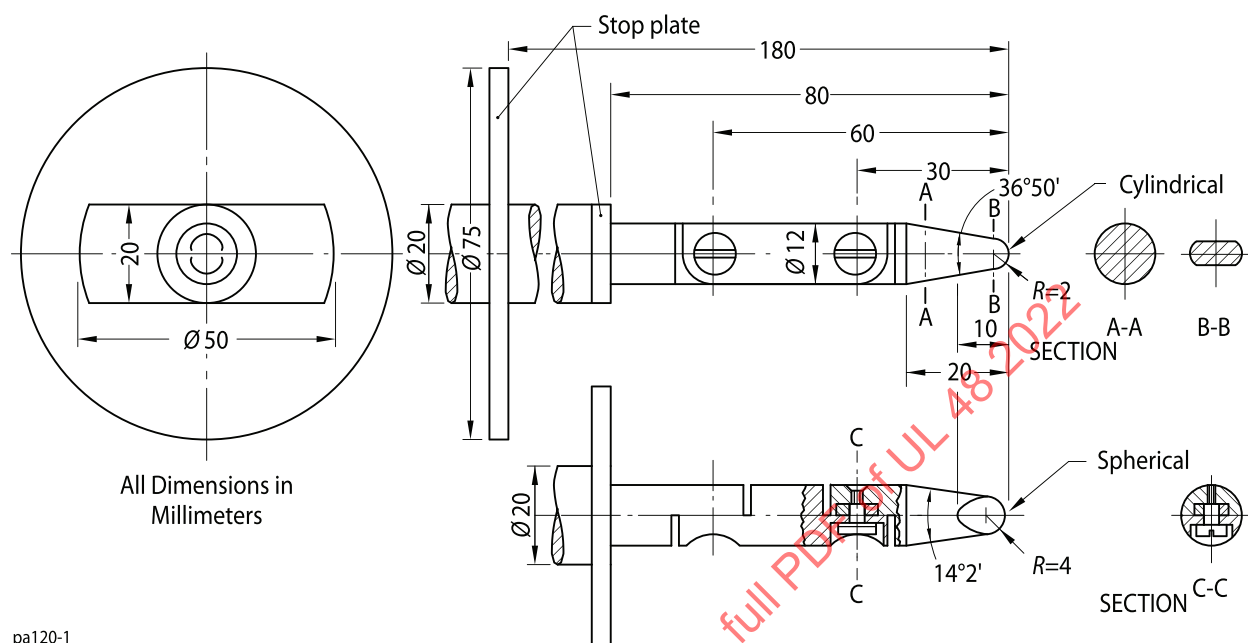


Figure 4.4

International Electrotechnical Commission (IEC) articulate accessibility probe with stop plate
courtesy of IEC



4.2.2.2.2 The lamp contacts of a screw-shell-type lampholder may be accessible while the lamp is being replaced.

4.2.2.3 Insulated parts

4.2.2.3.1 Except as noted in [4.2.2.3.2](#), all insulated live parts shall be made inaccessible during normal use and user maintenance. Accessibility is determined by the use of the articulate probes in [Figure 4.3](#) and [Figure 4.4](#).

4.2.2.3.2 The following insulated live parts may be accessible:

- a) A flexible cord;
- b) A wire rated 600 V or more that:
 - 1) Terminates at a lamp-supported lampholder,
 - 2) Has a minimum 0.69-mm (0.027-in) thick insulation, and
 - 3) Is covered collectively with other wires to the lampholder with nominal 0.5-mm (0.20-in) thick sleeving that extends from within 12.5 mm (0.50 in) of the lampholder to within an enclosure;
- c) The integral metal enclosure of a transformer, weatherproof and Outdoor Type 2 ballasts or any other component device identified as not needing to be made inaccessible;
- d) Fluorescent-lamp starters and starter-holder contacts;

- e) Flexible cord routed through the chain of a chain-pendant or the flexible cord of a cord pendant sign; and
- f) The conductors of a sign with a canopy over an outlet box that will be concealed after the sign is installed.

4.2.2.4 Wires, cords and cables

4.2.2.4.1 Flexible cords, equipment wire, and 600 V rated appliance wiring material may be accessible if:

- a) Visible for the entire length;
- b) Routed along a structural part of the sign, where practical, or threaded through chain links;
- c) Secured at least every 75 mm (3 in) if stranded wire or every 100 mm (4 in) if solid wire; and
- d) In compliance with either:
 - 1) Accessible for no more than 100 mm (4 in) and not containing any splices; or
 - 2) Accessible for no more than 100 mm (4 in) and enclosed in minimum 0.25-mm (0.010-in) thick fiberglass or thermoplastic sleeving. Factory made splices utilizing insulated crimp connectors are allowed in this sleeving.

4.2.2.4.2 GTO cable may be accessible if:

- a) Visible for the entire length,
- b) Routed along a structural part of the sign, where practical,
- c) Secured at least every 100 mm (4 in), and
- d) GTO cable sleeving is provided over GTO cable or integrally sleeved GTO is provided with or without GTO cable sleeving.

4.2.3 Spacings

4.2.3.1 Electrical

4.2.3.1.1 The minimum spacings between uninsulated live parts of opposite polarity, between an uninsulated live part and a grounded dead-metal part, and between an uninsulated live part and an accessible dead-metal part shall be as follows:

- a) Field wiring branch circuit supply terminals, dry, damp or wet location use – see [Table 4.6](#);
- b) Live parts not including field wiring branch circuit supply terminals:
 - 1) Spacings – For damp or wet location use, see [Table 4.7](#) and [Table 4.9](#), and
 - 2) Spacings – For dry location use only, see [Table 4.8](#).

Table 4.6
Spacings, at field wiring branch circuit supply terminals

Voltage range V	Minimum through-air and over-surface spacings between live and dead metal parts		Minimum spacings between live parts of opposite polarity			
			Through air		Over surface	
	mm	(in)	mm	(in)	mm	(in)
0 – 125	6.4	(0.25)	3.2	(0.127)	6.4	(0.25)
126 – 300	6.4	(0.25)	6.4	(0.25)	9.5	(0.375)
301 – 600	9.5	(0.375)	9.5	(0.375)	12.7	(0.50)

Table 4.7
Spacings, damp and wet locations, live parts, other than field wiring branch circuit supply terminals

Voltage range V	Through-air spacing		Over-surface spacing	
	mm	(in)	mm	(in)
0 – 15	3.2	(0.126)	6.4	(0.252)
16 – 30	3.2	(0.126)	6.4	(0.252)
31 – 50	3.2	(0.126)	6.4	(0.252)
51 – 100	3.2	(0.126)	6.4	(0.252)
101 – 150	3.2	(0.126)	6.4	(0.252)
151 – 170	6.4	(0.252)	9.5	(0.375)
171 – 250	6.4	(0.252)	9.5	(0.375)
251 – 300	9.5	(0.375)	12.7	(0.50)
301 – 600	9.5	(0.375)	19.1	(0.75)
601 – 1,000	9.5	(0.375)	19.1	(0.75)
1,001 – 2,500	19.1	(0.75)	25.4	(1.00)
2,501 – 5,000	25.4	(1.00)	25.4	(1.00)
5,001 – 10,000	38.1	(1.50)	38.1	(1.50)
10,001 – 15,000	38.1	(1.50)	50.8	(2.00)

Table 4.8
Spacings, dry locations only, live parts, other than field wiring branch circuit supply terminals

Voltage range V	Through-air		Over-surface	
	mm	(in)	mm	(in)
0 – 15	1.27	(0.05)	1.27	(0.05)
16 – 30	1.27	(0.05)	1.27	(0.05)
31 – 50	1.27	(0.05)	1.27	(0.05)
51 – 100	1.6	(0.063)	1.6	(0.063)
101 – 150	1.6	(0.063)	2.4	(0.094)
151 – 170	2.4	(0.094)	6.4	(0.25)
171 – 250	2.4	(0.094)	9.5	(0.375)
251 – 300	9.5	(0.375)	12.7	(0.50)

Table 4.8 Continued on Next Page

Table 4.8 Continued

Voltage range V	Through-air		Over-surface	
	mm	(in)	mm	(in)
301 – 600	9.5	(0.375)	19.1	(0.75)
601 – 1,000	12.7	(0.50)	19.1	(0.75)
1,001 – 2,500	25.4	(1.00)	25.4	(1.00)
2,501 – 5,000	25.4	(1.00)	25.4	(1.00)
5,001 – 10,000	31.8	(1.25)	38.1	(1.50)
10,001 – 15,000	38.1	(1.50)	50.8	(2.00)

Table 4.9
Spacings, dry, damp and wet locations, live parts, other than field wiring branch circuit supply terminals, on printed wiring boards with conformal coating or potting

Voltage range V	Over-surface	
	mm	(in)
0 – 15	0.13	(0.005)
16 – 30	0.25	(0.10)
31 – 50	0.38	(0.15)
51 – 100	0.51	(0.020)
101 – 150	0.64	(0.025)
151 – 170	0.76	(0.030)
171 – 250	0.76	(0.030)
251 – 300	0.76	(0.030)
301 – 600	1.52	(0.060)
601 – 1,000	3.05	(0.120)
1,001 – 2,500	7.62	(0.300)
2,501 – 5,000	15.2	(0.600)
5,001 – 10,000	25.4	(1.00)
10,001 – 15,000	30.5	(1.20)

4.2.3.1.2 The requirements of [4.2.3.1](#) are not applicable to the following components and circuitry:

- a) Parts encapsulated in a potting compound,
- b) The inherent spacings of discrete components,
- c) Circuitry operating within Class 2 limits, and
- d) Spacings in circuitry involving other than field-wiring terminals and live parts to accessible dead-metal are not prohibited from being evaluated to the spacing requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, as amended in [4.2.3.2.3](#), in lieu of the spacings in [Table 4.7](#) – [Table 4.9](#).

4.2.3.1.3 The spacings between uninsulated and insulated live parts of opposite polarity and between insulated parts, shall be as specified in [Table 4.10](#). The spacings between insulated live parts and the plane of a mounting surface in a sign shall be as specified in [Table 4.10](#).

Table 4.10
Spacings, live parts, uninsulated to insulated, insulated to insulated and insulated to dead metal,
regardless of conformal coating or potting

Voltage range V	Uninsulated to insulated,		Insulated in insulated,		Insulated to dead metal,	
	mm	(in)	mm	(in)	mm	(in)
0 – 600	not applicable		not applicable		not applicable	
601 – 1,000	19.1	(0.75)	6.4	(0.252)	3.2	(0.126)
1,001 – 2,500	19.1	(0.75)	9.5	(0.375)	6.4	(0.252)
2,501 – 5,000	19.1	(0.75)	12.7	(0.50)	6.4	(0.252)
5,001 – 10,000	28.4	(1.12)	19.1	(0.75)	9.5	(0.375)
10,001 – 15,000	38.1	(1.50)	25.4	(1.00)	12.7	(0.50)

4.2.3.1.4 The spacing requirements in the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, shall be amended as follows:

- a) For dry location only components, the Pollution Degree shall be 2;
- b) For damp or wet location components, the Pollution Degree shall be 3;
- c) Hermetically sealed or encapsulated enclosures,
- d) Cord-connected components shall be rated overvoltage Category II;
- e) Permanently-connected components shall be rated overvoltage Category III; and
- f) To apply Clearance B (controlled overvoltage), a component shall be provided with an integral overvoltage device or system.

4.2.3.1.5 Enameled and similar film-coated wire is identified as an uninsulated live part.

4.2.3.1.6 The spacings between output circuitry and dead-metal for a ground-referenced circuit shall be based on the maximum open-circuit voltage to ground.

4.2.3.1.7 Required spacings apply to signs when fully assembled.

4.2.3.1.8 No spacings are required between the GTO cable and the metal conduit/tubing in which it is routed.

4.2.3.1.9 The spacing between the windings of an open transformer or ballast (core and coils only) and the sign enclosure shall not be less than 12.7 mm (0.50 in) unless protective metal guards at least 0.66-mm (0.026-in) thick are provided as part of the transformer or ballast.

4.2.3.1.10 Minimum thicknesses of insulating materials shall comply with [Table 4.11](#).

Table 4.11
Minimum Thickness of Insulating Materials within 0.8 mm (0.031 in) of uninsulated live parts

Material	Minimum thickness of barrier/insulator		Damp and wet location signs	Dry location signs only
	mm	(in)		
Fiber	0.8	(0.031)	No	Yes ¹⁾
Phenolic composition	0.8	(0.031)	No	Yes ²⁾
Cold-molded composition	0.8	(0.031)	No	Yes ³⁾
Porcelain – glazed	3.2	(0.125)	Yes	Yes
Porcelain – unglazed	3.2	(0.125)	Only as tubes on insulated wires	Yes
Mica and inorganically bonded mica	0.8	(0.031)	Yes	Yes
Glass Sheet	3.2	(0.125)	Yes	Yes
Glass Tubing	2.5	(0.10)	Yes	Yes

¹⁾ The spacings to fiber from secondary parts (insulated and uninsulated) must comply with spacings between primary and secondary parts with no risk of contact between the fiber and a secondary lead that is installed or to which a connection is made in the field. Fiber shall only be used in circuits operating at 300 V or less.

²⁾ The spacings to phenolic from secondary parts (insulated and uninsulated) must not be less than 6.4 mm (0.25 in). There is to be no contact between the phenolic composition and a secondary lead that is installed or to which a connection is made in the field. Phenolic shall only be used in circuits operating at 300 V or less.

³⁾ Unglazed porcelain and cold molded composition is acceptable in dry locations only when not in contact with secondary parts (insulated or uninsulated) and inaccessible to contact by a secondary lead that is to be installed or to which a connection is made in the field. Cold-molded composition shall only be used in circuits operating at 300 V or less.

4.2.3.2 Thermal

4.2.3.2.1 General

4.2.3.2.1.1 Signs which comply with all the following thermal spacing requirements in [4.2.3.2](#) applicable to the sign are considered to comply with the temperature testing requirements of [5.2](#).

4.2.3.2.1.2 For purposes of this section, heat producing and arcing components include, but are not limited to transformers, ballasts, neon and LED power supplies, switches, relays, circuit breakers, incandescent lampholders, fluorescent lampholders, cold-cathode lampholders, and electrode housings and electrode receptacles.

4.2.3.2.1.3 Thermal spacings less than those specified in [4.2.3.2](#) may be provided if the sign complies with the temperature test requirements of [5.2](#) or the sign components have been evaluated for reduced minimum thermal spacings and the sign construction complies with those reduced component thermal spacings.

4.2.3.2.2 Internal Wiring and Component Spacings

4.2.3.2.2.1 Spacing between internal wiring and components shall comply with [Table 4.12](#).

Table 4.12
Spacings between internal wiring and components

Position and spacing ^{b)} of wiring	Minimum temperature rating of wire ^a or cord	
	°C	(°F)
Permanently spaced not less than 76 mm (3 in) from any ballast or transformer.	60	(140)
Less than 76 mm (3 in) from, and not in contact with, any ballast or transformer, other than for permanently attached leads at the point of entry to the ballast or transformer.	80	(176)
In contact with any ballast or transformer.	90	(194)
GTO cable in contact with (1) neon tube or (2) cold cathode tube electrode or (3) within 25.4 mm (1 in) of neon tube electrode.	105	(221)
^{a)} A permanently attached neoprene-insulated lead without a braid provided as a part of a ballast or a lampholder for a fluorescent or HID lamp is rated for a temperature of 90°C (194°F). Other permanently attached leads are rated for a temperature of at least 75°C (167°F). ^{b)} Spacings are not specified for wiring routed through a 2.5 mm (0.1 in) wall thickness glass tube. ^{c)} Wiring rated for a temperature of 75°C (167°F) or more is not prohibited from being used when provided with an outer braid.		

4.2.3.2.3 Component to component spacings

4.2.3.2.3.1 Spacings between transformers, ballasts, neon power supplies, and LED power supplies shall be at least 25.4 mm (1 in) from end to end and 101.6 mm (4 in) from side to side.

4.2.3.2.4 Polymeric and wood product spacings

4.2.3.2.4.1 Signs which contain thermoplastic, wood, fiber, or other combustible type materials shall comply with the following minimum thermal spacings to heat producing and arcing components:

- a) Minimum 50.8-mm (2-in) spacing between materials and lampholder, starter-holder, the inside rim of an electrode receptacle, live metal parts, incandescent lamp, high output lamp, compact lamp, and other parts that are a source of heat or arcing;
- b) Minimum of 12.7 mm (0.50 in) between material and fluorescent-lamp lampholder in dry location sign only;
- c) Minimum 25.4-mm (1-in) spacing between materials and enclosed transformer, ballast, or power supply when only one transformer, ballast or power supply are provided; and
- d) Minimum 12.7 mm (0.50 in) between materials and unenclosed transformer or power supply.

4.2.4 Grounding and bonding

4.2.4.1 General

4.2.4.1.1 Other than as specified in [4.2.4.1.3](#), all dead metal parts that are accessible to contact during normal use, during relamping, and servicing are required to be grounded.

4.2.4.1.2 To be considered grounded, a dead metal part is to be electrically connected or bonded to an equipment ground. This connection or bonding must be adequate such that the resistance to the grounding means to be no greater than 0.1 Ω.

4.2.4.1.3 The following dead metal parts are not required to be grounded:

- a) The links of a metal chain;

- b) Accessible non-current-carrying metal parts of components (for example, lampholders and switches) that are electrically isolated from live parts;
- c) Non-current-carrying metal parts that are electrically isolated by rigid insulation from live parts operating at a potential of 1000 V or less;
- d) Decorative parts, metal guards, and metal shades that do not enclose live parts;
- e) A dead metal part such as an adhesive-attached metal foil marking plate secured to the outside of an enclosure and mounting hardware external to the sign;
- f) Small metal parts not exceeding 50.8 mm (2 inch) in any dimension, not likely to become energized, and spaced minimum 19 mm (0.75 in) from neon tubing; and
- g) Remote metal parts of a section sign or outline lighting system only supplied by a remote Class 2 power supply shall not be required to be bonded to an equipment bonding conductor.

4.2.4.1.4 The continuity of the grounding and bonding system shall not rely on the dimensional stability of thermoplastic material unless the system complies with both of the following:

- a) The thermoplastic material has an RTI rating at least equal to the maximum operating temperature of the material in the sign and
- b) The grounding or bonding fitting complies with [5.14](#), Polymeric Ground/Bond Strength Test.

4.2.4.2 Grounding (bonding) dead metal parts to the equipment grounding means

4.2.4.2.1 All parts of a sign required to be grounded shall be conductively connected to the grounding terminal, lead, or pin of an attachment plug.

4.2.4.2.2 Bonding shall be accomplished by positive metal-to-metal contact of parts such as machine screw connections, rivets, bolts, soldering, or welding; or by a minimum 14 AWG (2.1 mm²) copper or copper alloy bonding conductor.

4.2.4.2.3 Bonding may also be accomplished by a thread cutting screw that complies with the self threading screw torque test of [5.20](#).

4.2.4.2.4 A bonding means shall not be compromised during component servicing.

4.2.4.2.5 Liquid-tight flexible metal conduit and flexible metal conduit are able to be used as a bonding means when they:

- a) Do not exceed 30 m (100 ft) in total accumulative length when enclosing wiring connected to secondary circuits operating over 1000 V; or
- b) Do not exceed 1.8 m (6 ft) in total accumulated length when enclosing wiring connected to the branch circuit supply; and
- c) Are used with grounding-type fittings rated or determined to be capable of being used for the intended purpose.

4.2.4.2.6 When conduit is used as a bonding means, an additional bonding conductor connecting the same parts shall not be provided.

4.2.4.2.7 Bonding conductors shall be installed separately and remotely from non-metallic conduit housing secondary circuit conductors. It shall be spaced at a minimum of 38.1 mm (1.50 in) from the

conduit when the secondary circuit operates at 100 Hz or less or 44.5 mm (1.75 in) when the circuit operates at above 100 Hz.

4.2.4.3 Equipment grounding means

4.2.4.3.1 General

4.2.4.3.1.1 An equipment grounding terminal or lead shall be provided within 152 mm (6 in) of the supply connection opening and shall not be removed during normal maintenance and servicing.

4.2.4.3.1.2 The grounding means shall be in the same location as the supply connection means and shall consist of a grounding conductor lead, a terminal connector, a wire binding screw, or the equivalent, and shall not be used for any other purpose.

4.2.4.3.1.3 A grounding connection wire binding screw or stud, or grounding lead shall be provided with a star washer or other fastening means that will penetrate a non-conductive coating such as paint.

4.2.4.3.1.4 A neutral (grounded) conductor shall not be connected to any grounding or bonding terminal or lead.

4.2.4.3.2 Terminal

4.2.4.3.2.1 A grounding terminal shall be a pressure wire terminal, wire binding screw or wire binding stud. A pressure wire terminal shall comply with the requirements in the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E, and be rated for the size and number of conductors used. A wire binding screw and stud shall comply with the requirements in this section.

4.2.4.3.2.2 A pressure wire connector provided for connection of an equipment-grounding conductor in the field shall be prevented from rotating by means other than friction between the terminal and mounting surface.

4.2.4.3.2.3 A wire binding screw or stud provided for grounding shall:

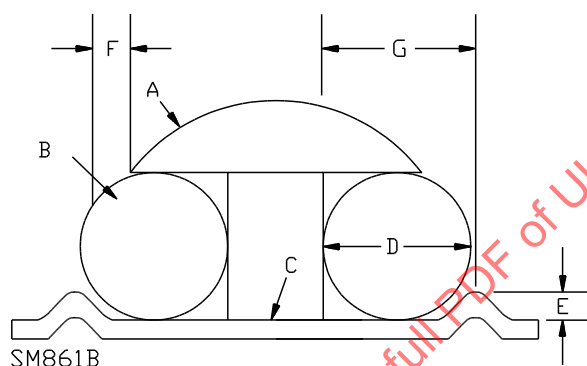
- a) Be limited to terminating a single size 10-, 12-, or 14-AWG (5.3-, 3.3-, or 2.1-mm²) conductor;
- b) Comply with [Table 4.13](#);
- c) Be a machine or thread-cutting screw and have a cupped washer or the area around the screw or stud shall be provided with two raised areas in accordance with [Figure 4.5](#). Other means of conductor captivation shall comply with the applicable requirements in the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.
- d) Have a base plate with no fewer than two full threads of contact and;
 - 1) Metal not less than 0.76-mm (0.030-in) thick; or
 - 2) Metal less than 0.76-mm (0.030-in) thick when a tapped hole for a screw having 1.25 threads per millimeter (32 or more threads per inch) is provided.

Table 4.13
Ground screw size

Screw size	Wire size
M3.5 – No. 6	14
M4 – No. 8	14 or 12
M5 – No. 10	14 or 10

Figure 4.5

Terminal and conductor relationship



A – Wire-binding screw

B – Conductor

C – Baseplate

D – Maximum conductor diameter, but not less than 2 mm (0.08 in)

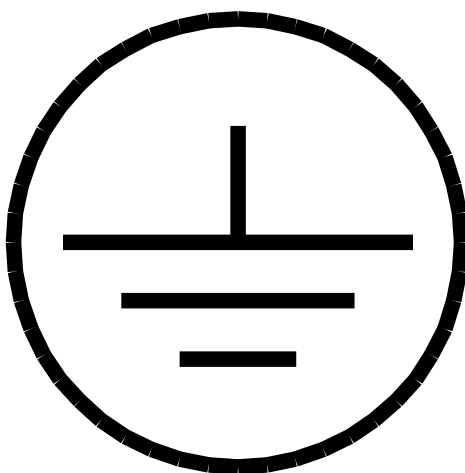
E – Minimum height of raised area shall be 1.0 mm (0.04 in)

F – The horizontal dimension from the edge of the screwhead to the inside edge of the raised area = 0 to 1/4 D

4.2.4.3.2.4 A wire binding stud/screw shall have a green colored head that is either hexagonal or round with a slotted or cross slotted (Phillips) head. The nut head shall be green in color or the area adjacent to the terminal shall be marked in accordance with [4.2.4.3.2.5](#).

4.2.4.3.2.5 A pressure wire terminal intended as connection of the equipment grounding conductor shall be plainly identified as "G," "GR," "GND," "Ground," "Grounding," or similar wording, or shall be marked with the symbol shown in [Figure 4.6](#).

Figure 4.6
Grounding symbol



4.2.4.3.3 Equipment grounding conductor

4.2.4.3.3.1 An equipment grounding conductor shall not be smaller than the gauge of the supply wires and no less than 14 AWG (2.1 mm²) when connected to a branch circuit supply.

4.2.4.3.3.2 An equipment grounding conductor shall have no insulation or insulation that is green with or without one or more yellow stripes and no other lead visible to an installer shall be so identified.

4.2.4.3.3.3 An equipment grounding conductor shall have a free length of at least 15.2 cm (6 in). The free length is measured from the point of entry of the conductor into the wiring compartment or from an opening for the connection of a permanent wiring system to the free end of the conductor.

4.2.4.3.3.4 An equipment grounding conductor shall be of copper or copper alloy.

4.2.4.3.3.5 When provided, a spade connector shall have upturned ends.

4.2.5 Wiring

4.2.5.1 General

4.2.5.1.1 A sign required to have drain openings shall have all wiring, other than wiring connected in an Class 2 circuit, supported so as to clear the bottom of the sign by at least 12.7 mm (1/2 in).

4.2.5.2 Supply connections

4.2.5.2.1 Permanently connected signs

4.2.5.2.1.1 A sign intended for permanent connection shall have provision for the connection to a permanent wiring system.

4.2.5.2.1.2 A field-wiring compartment provided on or within a sign shall be accessible for inspection after installation.

4.2.5.2.1.3 Except as noted in [4.2.5.2.1.4](#), lighting circuits within signs shall be rated 20 A maximum.

4.2.5.2.1.4 Neon lighting circuits within signs shall be rated 30 A maximum.

4.2.5.2.1.5 Leads provided for splice connection to branch-circuit wiring shall be:

- a) At least 152 mm (6 inch) in length;
- b) At least 18 AWG (0.82 mm²) when intended for splicing to a branch circuit conductor inside the sign or junction box integral to or attached to the sign;
- c) At least 12 AWG (3.3 mm²) when intended for external or remote connection to branch circuits up to 20 A and at least 10 AWG (5.3 mm²) when intended for external or remote connection to branch circuits rated 30 A that are permitted for neon signs; and
- d) Rated at least 600 Vac.

4.2.5.2.1.6 Unless provided with a wiring compartment as specified in [4.2.5.2.1.7](#), an opening provided for the purpose of making field connections to a branch circuit supply, shall be located at least 152 mm (6 in) away from the following:

- a) Uninsulated live parts,
- b) Low voltage circuitry,
- c) Heat producing components,
- d) Moving parts, and
- e) Any electrical or mechanical component not specifically identified above that could result in an increased risk of fire or shock.

4.2.5.2.1.7 The area adjacent to an opening where branch circuit supply connections are to be made in the field and which has components located within 152 mm (6 in) of the opening, shall be enclosed within a wiring compartment having a volume of at least 98 cm³ (6 in³).

4.2.5.2.2 Field-wiring terminals

4.2.5.2.2.1 A pressure wire type terminal or a wire binding screw shall be of the type suitable for field wiring.

4.2.5.2.2.2 A terminal intended for connection of a grounded conductor of an ac supply shall be metal substantially white or silver in color or be marked adjacent to the terminal with the words "NEUTRAL", "N", "W" or "White". No other terminal shall be substantially white or silver in color.

4.2.5.2.2.3 A terminal intended for connection of a dc supply shall be marked with the symbols "-" and "+" on or immediately adjacent to the supply terminals. The lettering and symbols shall be minimum 6.4-mm (0.025-in) high. Ink, paint, die stamping and other similar marking means are not prohibited from being used as the marking method.

4.2.5.2.2.4 A terminal intended for connection of secondary wiring external to the sign body or electrical enclosure shall be suitably rated for the connection of 18 AWG or larger conductors.

4.2.5.3 Separation of circuits

4.2.5.3.1 Wiring operating at different potentials shall comply with one or more of the following conditions:

- a) Wiring of different circuits and potential mechanically secured and routed to comply with the minimum spacing requirements in [Table 4.6](#) or [Table 4.7](#);
- b) Wiring of different circuits and potentials provided with a grounded metal barrier minimum 0.4-mm (0.016-in) thick, or other enclosure rated materials, between the two current carrying parts, with each part secured in a manner that maintains them on opposite sides of the barrier. The barrier shall have no openings; or
- c) Wiring of each circuit is provided with insulation rated for the highest voltage of all circuits.

4.2.5.4 Strain relief

4.2.5.4.1 Strain-relief shall be provided when a pull exerted on external wiring or cord would transmit to a splice, displace an internal component, or reduce spacings. The construction shall comply with the Strain-Relief Test, [5.4](#).

4.2.5.4.2 A strain-relief is not required when the conductors of the supply cord are assembled to a wiring device, such as a switch, a lampholder, or similar component, by the manufacturer of the wiring device such that the replacement of the cord requires the disassembly of the wiring device through the use of non-ordinary tools.

4.2.5.4.3 In cord-connected signs, internal and external wiring accessible during user servicing shall be provided with strain-relief such that strain is not transmitted to connections when tested in accordance with the Strain-relief Test, [5.4](#).

4.2.5.4.4 A strain-relief is not required to be provided when the conductor is integral to a ballast, lampholder, or a similar component that complies with the applicable requirements for the component, and the component is required to have strain-relief.

4.2.5.5 Secondary Circuits (0 – 1000 V)

4.2.5.5.1 General

4.2.5.5.1.1 Except as noted in [4.2.5.5.1.2](#) and [4.2.5.5.1.3](#), all current carrying parts shall comply with all the enclosure, accessibility, and electrical requirements of this standard.

4.2.5.5.1.2 A current carrying part located in a secondary circuit having a source of supply marked Class 2, with maximum open circuit voltage of 15 Vac, 21.2 Vpeak (and limited energy), or 30 Vdc is not required to comply with enclosure and accessibility requirements in this standard.

4.2.5.5.1.3 A current carrying part located in a secondary circuit having a source of supply marked Class 2, with maximum open circuit voltage of greater than 15 Vac, 21.2 Vpeak, or 30 Vdc is required to comply with accessibility requirements when the sign is designated for use in wet locations and is not required to comply with enclosure requirements in this standard.

4.2.5.5.1.4 Wiring of a sign shall be suitably rated for the voltage, temperature, and environmental conditions experienced in/on the sign and comply with [Table 4.14](#).

Table 4.14
Internal wiring by type and location

Type of wire	Permanently connected		Cord connected	
	Dry location	Wet and damp location	Dry location	Wet and damp location
MTW, RH, RHW, RHH, T, TW, THW, THWN, THHN, or XHHW Wire or UF cable	A1	A	A	A
Armored cable	A	A	A	A
Metal-clad cable	A	A	A	A
Fixture wire	A1	X	A	X
Appliance-wiring material, see 4.2.5.5.1.5	A1	A	A	A
A – Acceptable without conditions A1 – Acceptable under the conditions in paragraph 4.2.5.5.1.6 X – Not Acceptable in type and location of sign				

4.2.5.5.1.5 Appliance wiring material of a sign connected directly to a branch circuit supply source shall have a minimum insulation wall thickness of 0.8 mm (0.031 in) and be rated for the voltage and temperature involved.

4.2.5.5.1.6 Flexible cords and conductors are permitted when used as wiring of a sign between the pendant and canopy of a dry location permanently-connected chain-supported pendant canopy sign and:

- a) Is placed through the links of the chain;
- b) Is rated 600 V and be one of the types enumerated in [4.2.5.5.1.7](#), or of a type determined to be equivalent; and
- c) Is arranged such that the conductors do not carry any of the weight of the sign.

4.2.5.5.1.7 A sign employing a flexible cord used to mechanically support the pendant shall meet all of the following:

- a) The total weight of the pendant is 4.5 kg (10 lbs) or less;
- b) The cord is type S, SO, ST, STO, SJ, SJO, SJT, SJTO, or a cord type determined to be equivalent;
- c) The cord complies with the Strain Relief Test, [5.4](#).

4.2.5.5.1.8 All internal wiring shall be sized in accordance with [Table 4.15](#), unless subjected to a Temperature Test in [5.2](#).

Table 4.15
Conductor current ratings

Current A	Minimum conductor size	
	AWG	(mm ²)
0 – 10	18 or 16	(0.82 or 1.3)
over 10 – 12	14	(2.1)
over 12 – 16	12	(3.3)
16 – 24	10	(5.3)

4.2.5.5.1.9 Internal wiring supplied integral to a component and not removable by ordinary tools, such as lampholder leads or clock leads, need not comply with [4.2.5.5.1.4](#). These leads shall be as short as possible.

4.2.5.5.1.10 Secondary-circuit wiring of fluorescent or HID lighting shall be rated minimum 600 V, and shall not be rated less than the maximum voltage rating marked on the ballast or ballasts to which it is connected.

4.2.5.5.1.11 Class 2 circuits shall be wired using a Power Limited Circuit cable that complies with the Standard for Power-Limited Circuit Cables, UL 13, or with other wiring/cable that is suitably rated for higher voltages.

4.2.5.5.1.11A Class 2 circuit wiring shall be rated for the environment in which it is to be used, sized for the load imposed, and except as noted in [4.2.5.5.1.11B](#), not smaller than 18 AWG. See also, Field Wiring terminal, [4.2.5.2.2.4](#).

4.2.5.5.1.11B A minimum of 22 AWG is permitted for Class 2 circuit wiring that are contained within the sign enclosure or sign body and not intended for connection to field wiring.

4.2.5.5.1.11C Power-limited circuit cable shall be installed in accordance with the following:

- a) All exposed cables shall be mechanically supported at the maximum interval specified in [Table 4.5](#) and in accordance with [4.2.5.5.3](#). For cables that will be secured in the field, the maximum support interval shall be specified in the installation instructions;
- b) Connections and splices outside a sign body or enclosure shall be mechanically secured within 75 mm (3 in) of the connection point. This information shall be provided in the installation instructions if the connections are to be made or completed in the field;
- c) Connections and splices in a wet location, outside an enclosure or sign body, shall be made with insulating devices that are suitably rated for the environment; and
- d) Bends in the cable shall be made so as not to damage the cable and be no less than four times the overall diameter of the cable.

4.2.5.5.1.12 Cables and fittings that comply with the requirements of the Standard for Cable Assemblies and Fittings for Industrial Control and Signal Distribution, UL 2238 are considered to comply with this standard when used as interconnecting cables for signs, section signs, changing message signs, and outline lighting.

4.2.5.5.1.13 Types SO and STO flexible cord are permitted for wiring of a sign where essential flexibility is required and when the cord is exposed only during relamping or changing advertising material.

4.2.5.5.1.14 Types SO and STO flexible cord is permitted for wiring of a permanently connected sign to facilitate the use of sign modules that are not readily field serviceable and require field replacement, such as LED changing message modules. Flexible cord types SOW and STOW are required when the cord is exposed to water or sunlight.

4.2.5.5.2 Splices and connections

4.2.5.5.2.1 A splice shall be mechanically secured and shall provide reliable electrical contact. It shall be soldered unless a splicing device rated or constructed for the intended purpose is used.

4.2.5.5.2.2 A soldered joint and a splice made with an uninsulated wire connector shall be covered with minimum 3 turns of electrical insulating tape that complies with the Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape, UL 510, insulating tubing that complies with the Standard for Extruded Insulating Tubing, UL 224, or insulating sleeving that complies with the Standard for Coated Electrical Sleeving, UL 1441.

4.2.5.5.2.3 The voltage rating of an insulated wire connector shall not be less than the voltage of the circuit in which the connector is used.

4.2.5.5.2.4 A wire connector shall be used to join a combination consisting only of the sizes and numbers of wires for which it is rated.

4.2.5.5.3 Mechanical security and protection

4.2.5.5.3.1 Wiring shall be run and fastened reliably so as to be mechanically secure.

4.2.5.5.3.2 Wiring shall be protected or permanently positioned away from sharp edges and points, burrs, moving parts, and similar places where the insulation on conductors might be abraded or otherwise damaged during shipment, installation or use.

4.2.5.5.3.3 Wiring shall be protected or permanently positioned away from the threads and points of self-tapping screws, thread-cutting screws, self-drilling thread-cutting screws, thread-forming screws, or other screws with sharp edges and/or points, and machine screws of 0.48 cm (3/16 in) or smaller diameter.

4.2.5.6 Secondary circuits (over 1000 V)

4.2.5.6.1 General

4.2.5.6.1.1 A current carrying part located in a secondary circuit operating above 1000 Vac rms shall comply with enclosure, accessibility, and electrical requirements in this standard.

4.2.5.6.1.2 No spacings are required between the GTO cable and the metal conduit/tubing it is routed in.

4.2.5.6.1.3 Glass tubing that functions as an enclosure, an accessible barrier or a water shield shall;

- a) Be a minimum of 2.5-mm (0.1-in) thick,
- b) Be of borosilicate glass with no green color (no iron content),
- c) Be a single continuous length,
- d) Be mechanically supported every 305 mm (12 in), and
- e) Be mechanically secured in place at both ends.

4.2.5.6.1.4 Wiring of a sign shall be complete before it leaves the factory.

4.2.5.6.1.5 Wiring of a sign shall use GTO cable rated for its intended use.

4.2.5.6.1.6 Sharp bends in GTO cable shall be avoided and GTO shall be mechanically secured and protected.

4.2.5.6.1.7 GTO cable shall have insulation rated for the temperature involved and not less than 105°C (221°F).

4.2.5.6.1.8 All GTO cables shall be as short as possible.

4.2.5.6.1.9 Not more than 6.10 m (20 ft) of GTO cable shall be permitted in metallic conduit or tubing from a high-voltage terminal of a neon transformer or neon power supply to the first neon tube. Not more than 15.25 m (50 ft) of GTO cable shall be permitted in nonmetallic conduit from a high-voltage terminal of a neon transformer or neon power supply to the first neon tube.

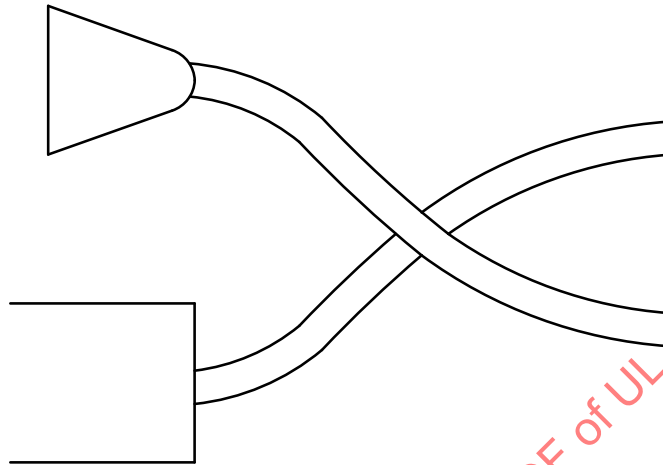
4.2.5.6.2 Splices and connections

4.2.5.6.2.1 GTO-to-neon electrode connections shall be mechanically secured providing electrical conductivity and soldered or mechanically secured as in [Figure 4.7](#) or [Figure 4.8](#).

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Figure 4.7
Over 1000 V GTO cable to electrode lead splice method
Twisted leads – option 1

Step 1



Step 2

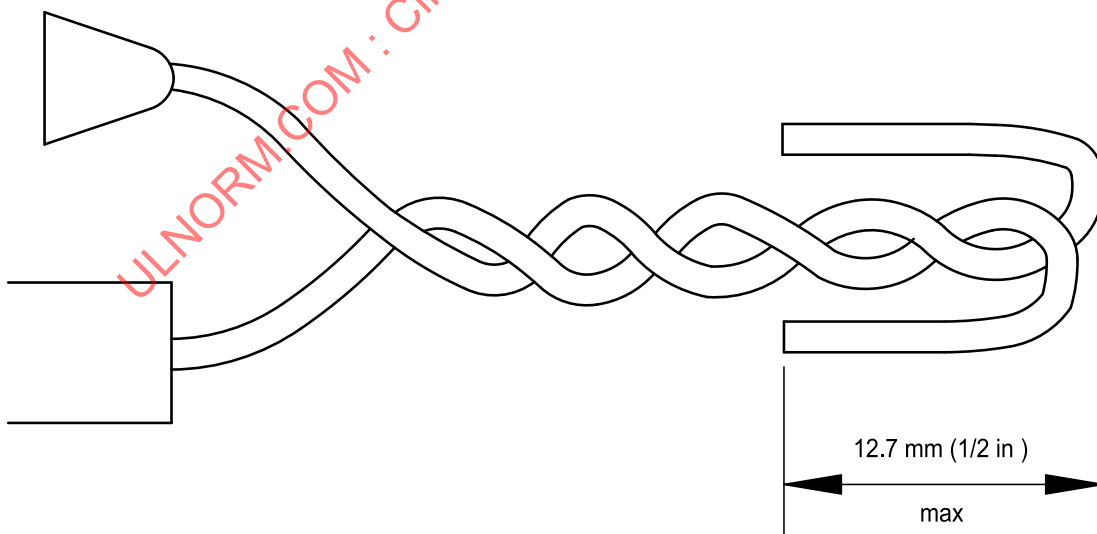
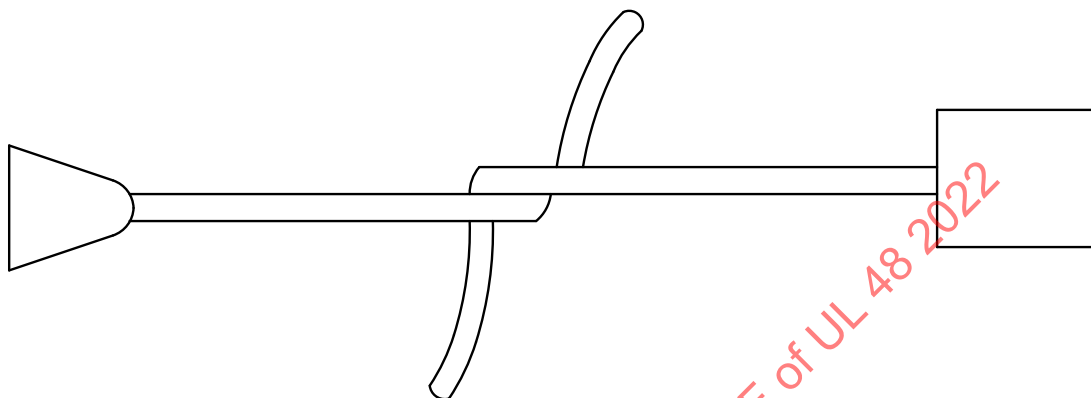
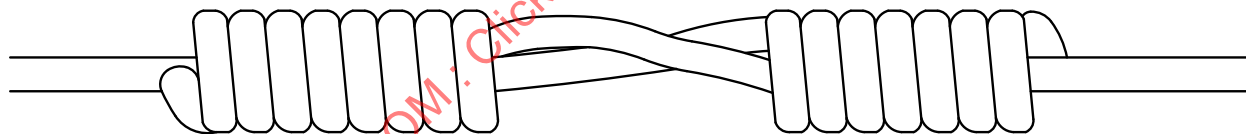


Figure 4.8
Over 1000 V GTO cable to electrode lead splice method
Twisted leads – option 2

Step 1



Step 2



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4.2.5.6.2.2 GTO-to-GTO connections shall be made using electrical devices that comply with the Standard for Electric Sign Components, UL 879.

4.2.5.6.3 Mechanical security and protection

4.2.5.6.3.1 GTO cable shall be protected by one of the following methods:

- a) Mounted on insulators and run inside an enclosure or raceway;
- b) Provided inside suitable conduit or tubing;
- c) Provided with sleeving complying with the Standard for Electric Sign Components, UL 879; or
- d) Identified as integrally sleeved GTO cable suitably rated for the voltage involved.

4.2.5.6.3.2 The insulation of a GTO cable shall extend beyond the end of an electrically conductive enclosure or raceway not less than the distance specified in [Table 4.16](#).

Table 4.16
Minimum spacing from metal enclosure or raceway to end of GTO insulation (refer to [4.2.5.6.3.3](#))

Voltage rating of GTO V	Minimum distance			
	Damp/wet location signs (e.g. skeleton neon tubing)		Dry location signs	
	mm	(in)	mm	(in)
5,000	51	(2.00)	38	(1.50)
10,000	76	(3.00)	51	(2.00)
15,000	102	(4.00)	64	(2.50)

4.2.5.6.3.3 Not more than one GTO cable shall be routed in a single conduit or tubing. No other conductors, including grounding conductors are permitted to run in the same conduit or tubing with the GTO cable.

4.2.5.6.3.4 Where Flexible Metal Conduit is used to enclose GTO cable, it shall be at least trade size 1/2.

4.2.5.6.3.5 In raceways, other than conduit or tubing, where more than one GTO cable is routed, each cable shall be routed to comply with the minimum spacings in [Table 4.16](#).

4.2.5.6.3.6 In conduit and tubing, the spacings between dead metal parts and insulated live parts greater than 1000 V specified in [Table 4.16](#) do not apply.

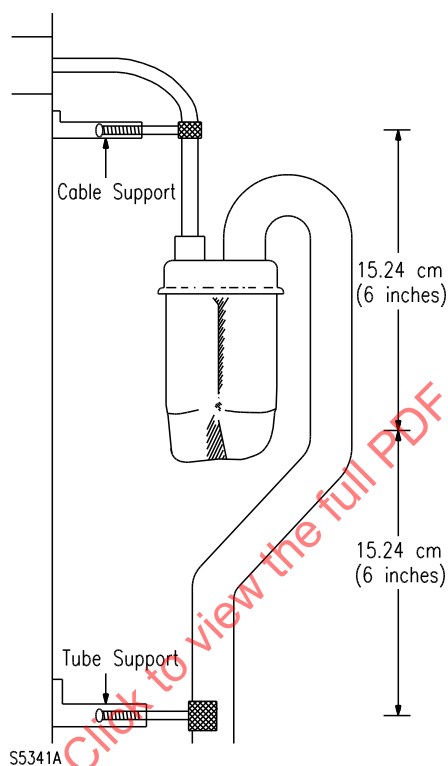
4.2.5.6.3.7 A metal enclosure or metal raceway that is too small to comply with the required spacings of [Table 4.16](#) and that houses one GTO cable connecting the neon supply and the first neon tube, shall not be longer than 6.10 m (20 ft).

4.2.5.6.3.8 A metal raceway that complies with the required spacings of [Table 4.16](#), and that houses the GTO cable connecting the neon supply and the first neon tube, does not have any length restriction.

4.2.5.6.3.9 A GTO cable support shall comply with the requirements of the Standard for Electric Sign Components, UL 879.

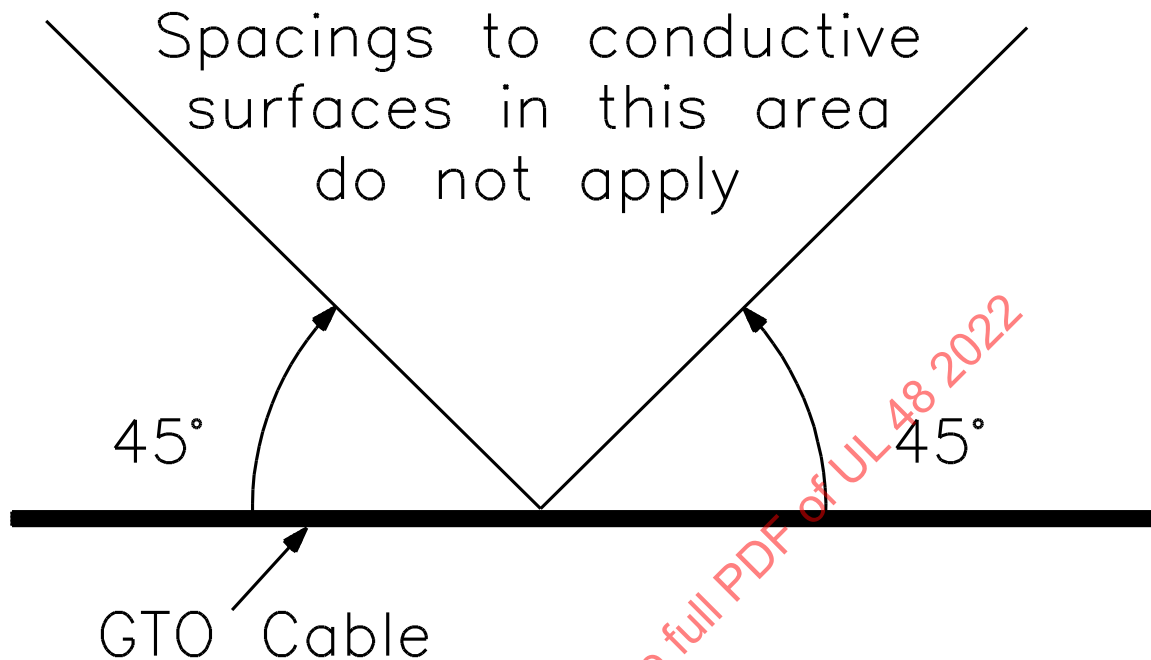
4.2.5.6.3.10 GTO cable supports and neon tube supports shall be located within 152 mm (6 in) of the neon tubing termination connections. See [Figure 4.9](#). Where electrode receptacles are provided, neon tube supports shall be within 152 mm (6 in) from the point where the neon tubing exists the receptacle.

Figure 4.9
Cable and neon tube support



4.2.5.6.3.11 GTO cable supports and neon tube supports that support GTO cable shall be positioned so that spacings are maintained per [4.2.3.1](#). When a GTO cable is routed through or to a conductive surface, and the angle between the surface and the GTO is $45^{\circ} - 90^{\circ}$, spacings to the surface do not apply. See [Figure 4.10](#).

Figure 4.10
GTO cable positioning



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4.2.6 Barriers and bushings

4.2.6.1 A barrier or bushing relied upon to comply with the Standard shall be mechanically secured in place. Adhesive shall not be used as the sole means to secure a barrier or bushing.

4.2.6.2 A barrier shall be rigid and self supporting.

4.2.6.3 Material that is not an integral part of a component and is within 0.8 mm (0.032 in) of uninsulated live parts shall be of non-absorptive, noncombustible material such as those indicated in [Table 4.11](#), or another material that complies with the requirements of the Standard for Electric Sign Components, UL 879.

4.2.6.4 Ordinary vulcanized fiber may be used for insulating bushings, separators and barriers, but not as the sole support for uninsulated live parts.

4.2.6.5 A barrier or bushing spaced greater than 0.8 mm (0.032 in) from uninsulated live parts, and used in a circuit operating at 600 V or less, shall be one of those specified in [Table 4.11](#) or Items 11 or 12 of [Table 5.1](#). The material shall not exceed the temperature limit specified in [Table 5.1](#) during Temperature Test.

4.2.6.6 A barrier or bushing is permitted to be in contact with insulated live parts and shall be one of those specified in [Table 4.11](#) or Items 11 or 12 of [Table 5.1](#). The material shall not exceed the temperature limit specified in [Table 5.1](#) during the Temperature Test.

4.2.6.7 Electrically conductive barriers provided to limit accessibility to uninsulated live parts shall be spaced per [4.2.3.1](#).

4.2.6.8 Barriers also functioning as a water shield shall additionally comply with the requirements for use as such.

4.2.6.9 Polymeric barriers shall that function as an insulating barrier shall comply with the Standard for Electric Sign Components, UL 879.

4.2.6.10 Cable Bushings for use with GTO shall comply with the requirements of the Standard for Electric Sign Components, UL 879.

4.2.6.11 An insulating cap provided on an electrode receptacle shall be secured in place. Spacings are to be measured through the joint between the cap and the receptacle.

4.3 Devices and components

4.3.1 General

4.3.1.1 Signs that use devices and components specified in [4.3](#) shall comply with the applicable requirements in [4.3](#).

4.3.1.2 Electrical devices shall be securely mounted as specified in the manufacturer's instructions. When mounting options exist, a minimum of two mechanical means of attachment are required.

4.3.1.3 Devices that rotate during normal setting or operation shall be mounted to prevent rotation by means other than friction alone. A properly applied lock washer, keyed opening, or similar means is considered to comply with this requirement.

4.3.1.4 An electrical device or component shall not be mounted on a hinged, sliding, or removable door or cover is required for user-servicing operations such as the changing of advertising material or replacement of lamps or lamp starters.

4.3.1.5 An electrical device or component intended for mounting in a wet or damp location sign shall be mounted to provide a minimum 12.7 mm (1/2 in) spacing off the bottom of a sign unless:

- a) The device or component is in a watertight enclosure, or
- b) The device or component is marked for use in wet locations, or
- c) The ballast, transformer, or neon supply is marked for wet location use, or
- d) The device has been evaluated for use in a wet location, or
- e) The sign is evaluated as watertight type enclosure.

4.3.1.6 For a vertically mounted circuit breaker, switch, or similar device with a marked on or off position, the up position shall be the on position.

4.3.1.7 No component shall use fiber or similar absorptive material.

4.3.1.8 Where exposed to the weather, a lampholder shall be rated as weatherproof.

4.3.1.9 Lampholders for use in damp or wet locations shall not employ an aluminum or aluminum alloy screw shell.

4.3.1.10 A porcelain or ceramic lampholder shall be glazed on all external surfaces.

4.3.1.11 If a general use snap switch is used for the sign disconnect, a switch boot that complies with the requirements of the Standard for Electric Sign Components, UL 879, shall be provided.

4.3.1.12 Ballasts used shall be marked Type 1 Outdoor, Type 2 Outdoor, Weatherproof, or WP.

4.3.1.13 Neon Supplies shall be marked "Outdoor", "Weatherproof", or "WP".

4.3.1.14 A lampholder used in a wet location sign that is not watertight shall employ insulation piercing or solder terminals. All exposed current-carrying parts of a soldered terminal shall be covered with an insulating compound (such as asphaltic paint or sealing compound), to reduce the risk of corrosion.

4.3.1.15 A neon tubing electrode enclosure system shall comply with the requirements of the Standard for Electric Sign Components, UL 879, for the intended use.

4.3.1.16 Electrical devices and components, including wiring, flexible cords and cables, shall not be painted or similarly coated with any material unless the components have been evaluated for use with the painting or coating used.

4.3.1.17 Flexible metal conduit may be painted if all of the following conditions are met:

- a) The flexible metal conduit is inside the sign;
- b) The flexible metal conduit is not relied upon for bonding or grounding; and
- c) The flexible metal conduit is secured in place and not subject to movement or flexing during routine user servicing such as lamp replacement or replacement of advertising.

4.3.2 Overcurrent protective devices

4.3.2.1 A fuseholder shall comply with the requirements of the Standard for Fuseholders – Part 1: General Requirements, UL 4248-1.

4.3.3 Switches and control devices

4.3.3.1 A switch, flasher, controller and the like, shall:

- a) Have a current rating equal to or greater than total current of the load; and
- b) When used for an inductive load, such as a ballast or transformer, be marked "L" or "AC General Use" for an AC circuit, or "T" for a DC circuit; and
- c) When used for an incandescent lamp or tungsten load, be marked "L" or "AC General Use" for an AC circuit, or "T" for a DC circuit; or
- d) Have a current rating exceeding the total current of the load multiplied times the factor in [Table 4.17](#).

Table 4.17
Switch derating factors

Switching load	Switch type				
	AC general use ac only	"L" rated ac only	"T" rated ac/dc	AC ampere rated only	AC/DC ampere rated
Transformer and ballast	1	1	1	2	2
Tungsten filament	1	1	1	3	3
Receptacle	1	1	1	3	3

1) An ac general use switch is typically a wall type switch normally used in a building and mounted to outlet boxes. An ac general use switch is also of the through cord type used on power supply cord connected products.

A switch, other than the ac general use type, that has been investigated for the control of inductive loads is marked with the letter "L" in conjunction with the current rating at which the inductive rating applies; for example, "1 A, 125 V, L".

A switch that has been investigated for the control of tungsten loads, is marked with the letter "T" in conjunction with the dc current rating at which the tungsten rating applies. A tungsten load is primarily an incandescent light source.

Switches with an ac, ac and dc or dc current rating with no "L", "T" or "AC General Use" marking are typically special use switches intended for resistive loads.

4.3.3.2 A control device, other than an AC general-use snap switch that controls a motor with a horsepower rating shall have a horsepower rating not less than that of the motor to be controlled.

4.3.3.3 An AC general-use snap switch (not an AC-DC general-use snap switch) may be used to control a motor load of two horsepower or less and shall be rated not less than 125% of the marked motor full load ampacity (FLA) at its rated voltage.

4.3.3.4 A single-pole device shall be connected in the ungrounded (line) conductor, or both the ungrounded and grounded (neutral) conductors if it simultaneously opens both conductors.

4.3.4 Disconnect switch

4.3.4.1 Unless marked in accordance with [7.1.7](#), a switch provided with the sign that is actuated external to the sign will be considered the sign disconnect switch and shall comply with [4.3.4.2](#) to [4.3.4.4](#) in accordance with the National Electrical Code, NFPA 70.

4.3.4.2 A disconnect switch shall have a marked "Off" position and shall disconnect the supply source by causing an air gap between opposing contacts in a circuit. When the switch is operated vertically rather than horizontally, the down position shall be the off position. The live terminal of the disconnect switch should be insulated or enclosed to prevent contact by service personnel.

4.3.4.3 If the disconnect is out of the line of sight from any section of the sign that is energized, the disconnect shall be capable of being locked in the off (open) position.

4.3.4.4 If the sign is operated by a controller, such as a time clock, external to the sign, the disconnect shall be located within sight of the controller or in the same enclosure as the controller, shall disconnect the sign and the controller at the same time, and shall be capable of being locked in the off (open) position.

4.3.5 Receptacles

4.3.5.0 General

4.3.5.0.1 A receptacle provided in or on a sign shall be in accordance with [4.3.5.1](#), [4.3.5.2](#) or [4.3.5.3](#).

4.3.5.0.2 A receptacle with or without a USB slot shall comply with the requirements in the Standard for Attachment Plugs and Receptacles, UL 498. An independent Class 2 output low-voltage connector (i.e. USB) slot shall comply with the requirements in the Standard for Class 2 Power Units, UL 1310.

4.3.5.1 Dedicated Receptacles

4.3.5.1.1 A sign is capable of being provided with receptacles that are dedicated for the connection of a specific product on or within the sign enclosure. The product that is intended for connection to the dedicated receptacle shall comply with the appropriate requirements for its product class.

4.3.5.1.2 A sign circuit supplying a dedicated receptacle shall have the circuit protected by supplementary overcurrent protection, such as a fuse, circuit breaker, or similar device, having a current rating not exceeding the applicable value specified in [Table 4.18](#).

Table 4.18
Supplementary overcurrent protective device current rating

Maximum supplementary overcurrent protective device rating A	Minimum cord conductor size rating		Minimum internal conductor size	
	AWG	(mm²)	AWG	(mm²)
10	18	(0.82)	18 ^a	(0.82)
13	16	(1.3)	18 ^a	(0.82)
15	14	(2.1)	14	(2.1)
18	14	(2.1)	12	(3.3)
20	12	(3.3)	12	(3.3)

^a Rated 90°C or 6 A maximum.

4.3.5.1.3 A marking identifying the product to be used with the dedicated receptacle shall be provided adjacent to each dedicated receptacle per [7.2.10](#).

4.3.5.2 Convenience Receptacles

4.3.5.2.1 A permanently connected sign is capable of being provided with one or more convenience receptacles.

4.3.5.2.2 Convenience receptacles are intended to supply independent products such as service and repair equipment only.

4.3.5.2.3 A maximum of 1 duplex convenience receptacle may be provided every 3.66 m (12 ft).

4.3.5.2.4 A convenience receptacle shall:

- For a dry location sign, be a 3-wire grounding-type receptacle, rated 15 or 20 A only, 125 V and compatible with (c) below;
- For a damp/wet location sign, be a 2-pole, 3-wire grounding-type Class A ground-fault circuit interrupter receptacle, rated 15 or 20 A only, 125 V with a weatherproof cover plate and compatible with (c) below;
- Provided with means for connection in the field to a 15 or 20 A maximum, 125 V branch circuit with no conductors common with other sign circuits;

- d) Be mounted on, or inside, the sign within a rated enclosure;
- e) Be mounted such that uninsulated live parts are inaccessible during sign servicing; and
- f) Be marked in accordance with [7.2.11](#) in a location immediately adjacent to the receptacle.

4.3.5.2.5 The circuit conductors for a convenience receptacle shall be sized in accordance with the ampere rating (15 or 20 A) of the receptacle and [Table 4.18](#).

4.3.5.3 Auxiliary Receptacles

4.3.5.3.1 Receptacles embedded in a sign to provide a supplementary or stand-alone function such as charging stations shall be accessible external to the sign enclosure.

4.3.5.3.2 Receptacles that derive power from within the sign electrical enclosure shall comply with:

- a) The supplementary circuit protection requirements in [4.3.5.1.2](#), and
- b) The marking requirement of [7.2.19](#).

4.3.5.3.3 Receptacles that are powered separate from all sign circuits and that are installed in a separate electrical enclosure attached to the sign shall comply with:

- a) The requirements in [4.3.5.2.4](#) sub-clauses a through e, and [4.3.5.2.5](#), and
- b) The marking requirements of [7.2.19](#) and [7.2.20](#).

4.3.6 Sign rotors/animators

4.3.6.1 Sign rotators and animators shall comply with the Standard for Electric Sign Components, UL 879.

4.3.7 Motor operated clocks

4.3.7.1 The motor of a motor operated clock shall comply with the requirements of either:

- a) The Standard for Time-Indicating and -Recording Appliances, UL 863, or
- b) The Standard for Rotating Electrical Machines – General Requirements, UL 1004-1, plus the applicable requirements from the Standard for Impedance Protected Motors, UL 1004-2, the Standard for Thermally Protected Motors, UL 1004-3, and the Standard for Electronically Protected Motors, UL 1004-7.

4.3.7.2 Clock mechanisms shall comply with the requirements in this Standard, and may additionally comply with the Standard for Electric Sign Components, UL 879.

4.3.8 Ballasts, transformers, LED drivers and power supplies

4.3.8.1 A transformer, ballast, LED driver or power supply shall be mounted on sheet steel that is minimum 0.66-mm (0.026-in) thick in compliance with [Table 4.2](#), or aluminum, brass, or copper that is minimum 0.76-mm (0.030-in) thick in compliance with [Table 4.3](#).

4.3.8.2 The mounting surface shall not deform under the weight of the device.

4.3.8.3 A ballast, transformer, LED driver or power supply shall be installed so that it is accessible, unless constructed in accordance with [5.3](#), when the sign is intended for use in dwellings.

4.3.8.4 A ballast, transformer, LED driver or power supply shall be installed so that the secondary connections are as short as possible. This shall be indicated in the installation instructions if they are to be mounted remotely.

4.3.9 Fans

4.3.9.1 Fans shall comply with the requirements of the Standard for Electric Fans, UL 507.

4.3.10 Heaters, air conditioners and controllers

4.3.10.1 Heaters shall comply with the requirements of the Standard for Electric Heating Appliances, UL 499.

4.3.10.2 Thermostats shall comply with the requirements of the Standard for Temperature-Indicating and -Regulating Equipment, UL 873 or the Standard for Automatic Electrical Controls for Household and Similar Use, Part 1: General Requirements, UL 60730-1.

4.3.10.3 Air Conditioners shall comply with the requirements of the Standard for Heating and Cooling Equipment, UL 1995 or the Standard for Room Air Conditioners, UL 484.

4.3.11 Changing message controllers

4.3.11.1 Changing message sign controllers shall comply with the requirements of the Standard for Electric Sign Components, UL 879.

4.3.12 GFCI

4.3.12.1 Portable, Mobile, and Stationary signs intended for damp or wet locations shall be provided with factory installed a GFCI. The GFCI shall be an integral part of the attachment plug or shall be located in the cord assembly within 30.5 cm (12 in) of the attachment plug.

4.3.12.2 A sign required to have a GFCI shall be provided with a Class A GFCI that complies with the Standard for Ground-Fault Circuit-Interrupters, UL 943.

4.3.13 Incandescent components

4.3.13.1 Lampholders

4.3.13.1.1 Lampholders shall comply with the Standard for Lampholders, UL 496.

4.3.13.1.2 Lampholders for use in other than a dry location sign application shall be marked for use in the intended environmental application. For example a lampholder for use inside an enclosed outdoor or wet location sign shall be marked for use in a damp location or for use in damp and/or wet location. Lampholders exposed directly to an outdoor or wet location environment shall be marked for use in a wet location.

4.3.13.2 Halogen/Xenon

4.3.13.2.1 A sign employing a halogen/xenon lamp shall be provided with a lamp containment barrier that will contain major particles resulting from a ruptured lamp, unless the lamp has been evaluated and determined not to need a containment barrier.

4.3.13.2.2 A lamp containment barrier shall consist of one of the following:

- a) 3.0-mm (0.118-in) thick minimum tempered or borosilicate glass;
- b) Polymeric material having a flammability classification of 5 VA;
- c) 3.175-mm (1/8-in) thick minimum polymeric material when it is positioned such that pieces of a ruptured lamp cannot come to rest on the material;
- d) A metal screen having maximum 3.3-mm (0.129-in) openings;
- e) A flexible polymeric material that complies with the requirements of Section [2.4](#);
- f) Ceramic; or
- g) Metal having a minimum thickness of 0.41 mm (0.16 in).

4.3.13.2.3 Glass and plastic lamp containment barriers not complying with the above requirements, shall comply with the lamp containment barrier melt-through test of [5.13](#).

4.3.14 Fluorescent components

4.3.14.1 Lamps

4.3.14.1.1 A U-shaped double-ended fluorescent lamp shall be reliably secured in place in addition to the support at the lampholders.

4.3.14.2 Lampholders, starters and starter holders

4.3.14.2.1 Lampholders and starter holders shall comply with the Standard for Lampholders, UL 496.

4.3.14.2.2 Starters shall comply with the Standard for Fluorescent Lamp Starters, UL 542.

4.3.14.2.3 Circuit interrupting lampholders shall be provided when required by the ballast marking.

4.3.14.2.4 Lampholders of the single pin type shall have the circuit-interrupting mechanism in the lampholder with the stationary contacts.

4.3.14.2.5 Circuit interrupting lampholders shall be connected in the supply side of the ballast.

4.3.14.2.6 Integral leads of a lampholder for a circular fluorescent lamp shall be accessible for a distance not greater than 76.2 mm (3 in) to permit connection of the lampholder to the lamp; strain-relief complying with the requirements in [5.4](#) shall be provided.

4.3.14.2.7 Fluorescent lampholders for use in other than a dry location sign application shall be marked for use in the intended environmental application. For example a lampholder for use inside an enclosed outdoor or wet location sign shall be marked for use in a damp location or for use in damp and/or wet location. Lampholders exposed directly to an outdoor or wet location environment shall be marked for use in a wet location.

4.3.14.3 Ballasts

4.3.14.3.1 Ballasts shall comply with the Standard for Fluorescent-Lamp Ballasts, UL 935, and except as noted in [4.3.14.3.2](#) shall be Class P.

4.3.14.3.2 A simple reactance ballast connected to straight tubular fluorescent lamps is not required to be Class P.

4.3.14.3.3 A sign using a fluorescent ballast marked with an output potential greater than 300 V intended for use with double ended lamps shall comply with the following:

a) For a ballast having an output voltage of less than 1000 Vac, the lampholders shall be of the single pin circuit interrupting type that interlocked the primary circuit so that the circuit is automatically de-energized during relamping and all live parts shall not be accessible when the lamp is removed and the primary circuit is reenergized, and

b) For ballasts having an output current of 800 to 1500 mA and greater than 40 W, the lampholders shall be of the recessed-contact type.

4.3.15 HID components

4.3.15.1 Lampholders

4.3.15.1.1 Lampholders shall comply with the Standard for Lampholders, UL 496.

4.3.15.1.2 HID lampholders for use in other than a dry location sign application shall be marked for use in the intended environmental application. For example a lampholder for use inside an enclosed outdoor or wet location sign shall be marked for use in a damp location or for use in damp and/or wet location. Lampholders exposed directly to an outdoor or wet location environment shall be marked for use in a wet location.

4.3.15.1.3 Lampholders connected to ballasts/starters/igniters with a pulse rating shall be suitably rated.

4.3.15.2 Starters/igniters

4.3.15.2.1 Starters/igniters shall comply with the requirements of the Standard for High-Intensity-Discharge Lamp Ballast, UL 1029.

4.3.15.3 Ballasts

4.3.15.3.1 Ballasts shall comply with the requirements of the Standard for High-Intensity-Discharge Lamp Ballast, UL 1029.

4.3.15.3.2 With regard to temperature testing, the following representations apply:

a) A metal halide or mercury vapor ballast shall not represent a high pressure sodium ballast, and vice versa;

b) A lower wattage shall not represent a higher wattage;

c) A ballast with one class insulation system shall not represent a ballast with a different class insulation system;

d) A ballast with a bench test rise code shall not represent a ballast with a higher rise code; and

e) A ballast that is not thermally protected shall not represent a thermally protected ballast, and vice versa.

4.3.16 Metal halide components

4.3.16.1 A sign employing a metal halide lamp shall be provided with a lamp containment barrier that will contain major particles resulting from a ruptured lamp, unless the lampholder will accept only a Type O lamp.

4.3.16.2 A lamp containment barrier shall consist of one of the following:

- a) 3.0-mm (0.118-in) thick minimum tempered or borosilicate glass;
- b) Polymeric material having a flammability classification of 5 VA;
- c) 3.175-mm (1/8-in) thick minimum polymeric material when it is positioned such that pieces of a ruptured lamp cannot come to rest on the material;
- d) A metal screen having maximum 3.3-mm (0.129-in) openings;
- e) A flexible polymeric material that complies with the applicable requirements of the Standard for Electric Sign Components, UL 879;
- f) Ceramic; or
- g) Metal having a minimum thickness of 0.41 mm (0.016 in).

4.3.16.3 Glass and plastic lamp containment barriers not complying with the above requirements, shall comply with [5.13](#), the lamp containment barrier melt-through test.

4.3.17 Neon/cold cathode components

4.3.17.1 General

4.3.17.1.1 Doors or covers intended to allow inspection of splices after installation shall not be obstructed by neon tubing or have anything mounted to them or over them.

4.3.17.2 Electrode receptacles

4.3.17.2.1 Electrode receptacles shall be rated for the purpose and comply with the Standard for Electric Sign Components, UL 879.

4.3.17.2.2 The milliamp rating of an electrode receptacle shall not be less than the neon supply's output milliamp rating.

4.3.17.3 Tube supports

4.3.17.3.1 Neon tubing shall be supported by tube supports or enclosure rated sign-face materials that comply with the Standard for Electric Sign Components, UL 879.

4.3.17.4 Ballasts, transformers, and power supplies

4.3.17.4.1 Neon supplies (power supplies and transformers) and cold cathode supplies (power supplies and transformers) shall comply with the Standard for Neon Transformers and Power Supplies, UL 2161.

4.3.17.4.2 Cold cathode ballasts shall comply with the Standard for Fluorescent-Lamp Ballasts, UL 935.

4.3.17.4.3 The windings of two or more transformers or power supplies shall not be electrically connected.

4.3.17.4.4 Type 1 neon supplies are open core-and-coil and shall be mounted in a complete enclosure.

4.3.17.4.5 Type 2 neon supplies shall have the input and output terminals, leads, and connections enclosed.

4.3.17.4.6 Type 3 neon supplies are intended for connection to a permanent wiring system and shall have the secondary leads or terminals enclosed.

4.3.17.4.7 Type 4 neon supplies are intended for connection to a permanent wiring system (fully enclosed) and do not need to be provided with an additional enclosure.

4.3.17.4.8 Type 5 neon supplies are intended for connection to a permanent wiring system (fully enclosed), are provided with integral output receptacles, and do not need to be provided with an additional enclosure.

4.3.17.4.9 Type 6 neon supplies are cord-connected, provided with integral output receptacles, and do not need an additional enclosure.

4.3.17.4.10 Type 7 neon supplies are cord-connected and shall have the secondary leads or terminals enclosed.

4.3.17.4.11 Type 8 neon supplies are cord-connected and do not need an additional enclosure.

4.3.17.5 Neon circuit components

4.3.17.5.1 Electrode splice enclosures, GTO cable splice enclosures and GTO cable sleeving shall comply with the Standard for Electric Sign Components, UL 879.

4.3.17.5.2 GTO cable shall comply with the Standard for Gas-Tube-Sign Cable, UL 814, and integrally sleeved GTO cable shall comply with the Standard for Gas-Tube-Sign Cable, UL 814, and the Standard for Electric Sign Components, UL 879.

4.3.17.5.3 Electrode receptacles, glass cup receptacles and conduit plug assemblies shall comply with the Standard for Electric Sign Components, UL 879.

4.3.17.5.4 Polymeric neon tube supports shall comply with the Standard for Electric Sign Components, UL 879.

4.3.17.6 Lampholders

4.3.17.6.1 Lampholders operating at potentials above 1000 V shall comply with the Standard for Electric Sign Components, UL 879.

4.3.17.6.2 Lampholders operating at potentials of 0 – 1000 V shall comply with the Standard for Fluorescent Lamp Starters, UL 542.

4.3.17.6.3 Circuit-interrupting lampholders shall be provided when required by the ballast marking.

4.3.17.6.4 Lampholders of the single pin type shall have the circuit-interrupting mechanism in the lampholder with the stationary contacts.

4.3.17.6.5 Circuit interrupting lampholders shall be connected in the line side of the ballast.

4.3.18 LED illumination

4.3.18.1 LED displays provided as either a panel or module for use in a sign shall comply with the requirements of the Standard for Electric Sign Components, UL 879.

4.3.19 Specialty lighting

4.3.19.1 Electro-luminescent

4.3.19.1.1 Electroluminescent display faces provided as either a panel or strip in a sign and the power source to energize them shall comply with the requirements of the Standard for Electric Sign Components, UL 879.

4.3.19.2 Induction lighting

4.3.19.2.1 Signs employing induction lighting systems shall comply with the requirements for signs employing fluorescent lighting systems referenced herein.

4.3.19.3 LCD

4.3.19.3.1 LCD power supplies shall comply with the requirements of the Standard for Electric Sign Components, UL 879, the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, or the Standard for Audio/video, Information and Communication Technology Equipment – Part 1: Safety Requirements, UL 62368-1.

4.3.19.3.2 *Deleted*

4.3.19.3.3 *Deleted*

4.4 Supplementary requirements

4.4.1 Cord-connected signs

4.4.1.1 Except as noted in [4.4.1.2](#), signs not intended for permanent connection to a source of supply, including stationary, portable, and trailer mounted signs, shall be provided with a power supply cord that complies with the requirements of [4.4.1](#).

4.4.1.2 A sign intended to be connected to a separate cord connected power supply or a direct plug-in power supply shall be provided with a suitable connector to allow attachment to the output cord of the power supply.

4.4.1.3 The power supply cord for a trailer-mounted sign shall be of the following type: SW, SW-A, SOW, SOW-A, STW, STW-A, STOW, STOW-A, or STOW-A.

4.4.1.4 The power supply cord for a sign, other than a trailer mounted sign, intended for use in a wet location shall be of the type in [4.4.1.3](#) or the following: SJW, SJW-A, SJTW, SJTW-A, SJOW, SJOW-A, SJTOW, or SJTOW-A.

4.4.1.5 The power supply cord for a sign intended for use in a dry or damp location shall be of the type in [4.4.1.3](#), [4.4.1.4](#), or the following: S, ST, SO, SJ, SJO, SJT, SJTO, SP-2, SPT-2, SP-3, or SPT-3.

4.4.1.6 Except as noted in [4.4.1.7](#), all cord connected signs shall comply with the leakage current test in [5.19](#).

4.4.1.7 Cord connected signs employing only neon or LED power supplies, Class 2 power supplies, transformers, or ballasts for sign illumination and evaluated for use in signs need not comply with [5.19](#).

4.4.1.8 The power supply cord shall be provided with a strain relief means and comply with the strain relief test. See [5.4](#).

4.4.1.9 A power supply cord provided with a knot in the cord to comply with the strain relief test in [5.4](#) shall not bear against or be able to come in contact with a surface that has projections, sharp edges, fins, or the like that could damage the conductor insulation.

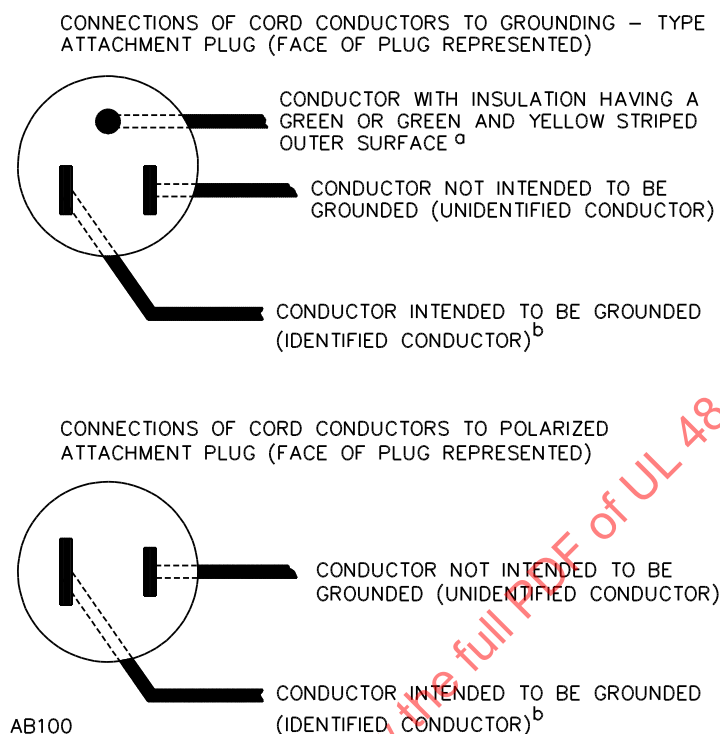
4.4.1.10 A flexible cord shall be provided with push back strain relief means such that pushing back the cord into an enclosure will not transmit strain to connections, damage the cord by contact with moving parts, or result in contact with a heat producing component with a maximum temperature rating in excess of the temperature rating of the flexible cord.

4.4.1.11 A strain relief means shall be provided at both ends of a flexible cord when the flexible cord supports a sign or sign part.

4.4.1.12 Except as noted in [4.4.1.13](#), all cord connected signs shall be provided with a supply cord with grounding conductor. The grounding conductor shall be connected to user accessible metal of the sign and to the fixed grounding member of the attachment plug.

4.4.1.13 A sign, other than a trailer sign, that has no accessible dead metal likely to become energized, shall be permitted to employ a two wire supply cord with polarized attachment plug as show in [Figure 4.11](#).

Figure 4.11
Connection to attachment plug



^a The blade to which the green conductor is connected may have a U-shaped or a circular cross section.

^b The identified conductor is the conductor that is intended to be grounded.

4.4.1.14 A sign intended for installation in a dry location and supplied from a separate cord connected Class 2 supply is not required to be provided with a grounding type cord or a polarized cord and plug combination.

4.4.1.15 A three-conductor flexible cord with ground shall be provided with conductor identification to identify grounded and grounding conductors. A jacketed cord such as a SJT type shall have the grounding conductor within the jacket colored green or green with a yellow stripe and the grounded conductor shall be colored white or gray.

4.4.1.16 When a two-conductor flexible cord is provided for connection to the source of supply and polarity is required, the conductors shall be connected to a polarized parallel-blade attachment plug with the identified grounded conductor (neutral) connected to the wider blade. A parallel cord such as Type SPT-2 shall have a stripe, ridge, or groove on the exterior of the cord surface of the grounded (neutral) conductor for identification.

4.4.1.17 A flexible cord shall be minimum 18 AWG (0.82 mm²).

4.4.1.18 All detachable and non-detachable supply cords on other than mobile type signs shall be minimum 1.83 m (6 ft) and maximum 4.57 m (15 ft) in length. A non-detachable supply cord that is less than 1.83 m (6 ft) in length and no less than 0.33 m (1 ft) in length is acceptable when the sign is designated only as a wall-mounted or hanging type. The length shall be measured from the point where the cord emerges from the sign component, or after any strain-relief means provided, to the point where the cord enters an attachment plug.

4.4.1.19 Flexible supply cords shall be provided with a bushing at the point where the cord passes through an opening in a metal enclosure or through a non-rounded opening of a polymeric enclosure. The bushing shall be secured in place and have a smooth, rounded surface against which the cord bears. The bushing shall be an insulating type if the cord is Type SVT or lighter.

4.4.1.20 The attachment plug of a cord-connected sign component shall be rated for a 15 or 20 A branch circuit or a 30 A branch circuit when supplying a neon circuit.

4.4.1.21 The ampacity of the attachment plug of a detachable and non-detachable power supply cord shall not be less than 125% of the input rating for a product intended to be continuously operated for 3 h or more.

4.4.1.22 Damp or wet location portable signs shall not be provided with an attachment plug rated greater than 125 V.

4.4.1.23 Flexible cord is permitted for wiring in a dry location permanently-connected pendant canopy sign, dry location permanently-connected wall-mounted sign provided with a pendant, or an dry location cord-connected freestanding sign provided with a pendant when:

- a) The flexible cord is used between the pendant and canopy or body of the sign;
- b) The cord has no more than 152 mm (6 in) at each end of the cord inside the sign;
- c) The total weight of the sign is 4.5 kg (10 lbs) or less;
- d) The cord is Type S, SO, ST, STO, SJ, SJO, SJT, SJTO, or another cord determined to be equivalent. The standard types of flexible cord other than those specified are not identified as rated for the support of pendant signs or the pendant portion of a sign. A cord not mentioned is to be subjected to an investigation to determine whether the cord is capable of being used as the support of a pendant sign or the pendant portion of a sign;
- e) The cord is installed to comply with [4.2.5.2](#);
- f) All exposed dead metal parts are grounded in accordance with [4.2.4](#).

4.4.2 Signs using Class 2 LED illumination system

4.4.2.1 This section provides supplemental requirements or references to requirements in other sections of this standard that are applicable to LED signs supplied by a Class 2 power source.

4.4.2.2 LED illuminated signs, section signs and outline lighting shall comply with all applicable wiring and construction requirements in this standard.

4.4.2.3 LED illumination systems for use in signs and LED displays provided as either a panel or module for use in a sign shall comply with the requirements of the Standard for Electric Sign Components, UL 879.

4.4.2.3.1 LED Retrofit Kits for installation in a sign shall comply with the requirements of the Standard for LED Sign and Sign Retrofit Kits, UL 879A.

4.4.2.4 Power sources for Class 2 LED illumination systems shall comply with the Standard for Class 2 Power Units, UL 1310, or the Class 2 requirements of the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3.

- a) Where multiple Class 2 power sources are installed in an enclosure or sign body, the power source shall comply with the spacing requirements of [4.2.3.2.3.1](#).

b) Conductors operating at different potentials than Class 2 in an enclosure shall be separated or segregated from the Class 2 conductors.

4.4.2.5 Wiring for use in the secondary of a Class 2 LED illumination system shall be selected in accordance with [4.2.5.5.1.11](#) to [4.2.5.5.1.11B](#).

4.4.2.6 Power limited circuit cables installed in secondary circuits of Class 2 LED signs shall be in accordance with [4.2.5.5.1.11C](#).

4.4.2.7 An uninsulated live part in the secondary of a Class 2 circuit may be accessible in a sign intended for installation in a dry location.

4.4.2.8 An uninsulated live part in the secondary of a Class 2 circuit may be accessible in a sign intended for installation in a damp or wet location sign if the output of the Class 2 supply does not exceed 15 Vac rms/21.2 Vpeak and 30 Vdc.

4.4.2.9 Uninsulated live parts connected to isolated, low voltage Class 2 circuits not exceeding 30 Vac/42.4 Vpeak and 60 Vdc for dry location products and not exceeding 15 Vac/21.2 Vpeak and 30 Vdc for damp and wet location products may be accessible.

4.4.2.10 A current carrying part located in a secondary circuit having a source of supply marked Class 2, with a maximum open circuit voltage of 15 Vac, 21.2 Vpeak and 30 Vdc is not required to comply with enclosure and accessibility requirements in this standard.

4.4.2.11 A current carrying part located in a secondary circuit having a source of supply marked Class 2, with maximum open circuit voltage of greater than 15 Vac, 21.2 Vpeak, or 30 Vdc is required to comply with accessibility requirements when the sign is designated for use in wet locations and is not required to comply with enclosure requirements in this standard.

4.4.2.12 All dead metal parts of a LED illumination system shall be bonded to the equipment ground of the power supply circuit in accordance with [4.2.4](#), noting in particular [4.2.4.1.3\(g\)](#).

4.4.3 Outlet box connected (canopy signs)

4.4.3.1 A sign weighing 22.7 kg (50 lbs) or less and intended for outlet box mounting shall be provided with means for mounting to an outlet box, such as a strap or crossbar not more than 38-mm (1-1/2-in) wide, or with one or two pairs of holes or keyhole slots for mounting the sign directly to an outlet box.

4.4.3.2 A supporting strap or crossbar shall be secured to the sign by two or more fastenings, and shall not be less than 1.35-mm (0.053-in) thick when of steel or 1.91-mm (0.075-in) thick when of other metal.

4.4.3.3 A supporting strap that is reinforced by flanges along the edge shall be minimum 1.0-mm (0.040-in) thick, when of steel and 1.4-mm (0.055-in) thick, when of other material.

4.4.3.4 A canopy sign weighing more than 22.7 kg (50 lbs) and intended for outlet box mounting shall be provided with means for support that is independent of the outlet box and shall comply with the mounting test in [5.6](#).

4.4.3.5 A canopy sign weighing more than 4.5 kg (10 lbs) shall be provided with a means to access the splice connections without removing the sign from its mounting means.

4.4.3.6 Supply conductors (from the sign, outlet box, or a canopy switch) and the splices between them are considered to be enclosed between the canopy and the wall or ceiling when:

- a) The conductors and splices are not accessible when the sign is installed;
- b) The maximum dimension of the canopy (including diagonal) is 380 mm (15 in); and
- c) The conductors are long enough to extend 152.4 mm (6 in) into the outlet box.

4.4.4 Trailer signs

4.4.4.1 The power supply cord for a trailer-mounted sign shall comply with the applicable requirements of [4.4.1](#).

4.4.4.2 The size and length of the power supply cord for a trailer-mounted sign shall comply with [Table 4.19](#).

Table 4.19
Supply-conductor size for mobile signs

Length of cord		Minimum cord-conductor size					
		15-A plug		20-A plug		30-A plug	
mm	(ft)	AWG	(mm ²)	AWG	(mm ²)	AWG	(mm ²)
1.8 – 15	(6 – 50)	14	(2.1)	12	(3.3)	8	(8.4)
Over 15	(Over 50)	12	(3.3)	10	(5.3)	6	(13.3)

4.4.4.3 The sign shall have provisions for permanent mounting.

4.4.4.4 The trailer sign shall be marked in accordance with [7.4.1](#).

4.4.5 Awning signs

4.4.5.1 An awning sign, including retractable awning signs, shall be provided with a means to be permanently connected to a source of supply and permanently mounted.

4.4.5.2 Except as noted in [4.4.5.4](#), luminaires (lighting fixtures) provided as part of an awning sign, shall comply with the requirements in the Standard for Luminaires, UL 1598, for wet locations.

4.4.5.3 Where a wet location luminaire is required, means for connection to a source of supply shall use suitable watertight conduit and watertight fittings.

4.4.5.4 A luminaire complying with the requirements in the Standard for Luminaires, UL 1598, and suitable for damp locations may be used only if all of the following conditions are met:

- a) The awning material, flexible or rigid, shall comply with the Standard for Electric Sign Components, UL 879, for wet locations,
- b) The awning shall not be retractable, and
- c) The luminaires shall be mounted where they are not exposed to rain.

4.4.5.5 All awning material shall be mechanically secured to the awning framework. Flexible awning material, when provided, shall be taut over the framework and shall be designed to prevent the accumulation of water on any portion of the material.

4.4.5.6 Luminaires that comply with the requirements in the Standard for Luminaires, UL 1598, are not required to additionally comply with the requirements in this Standard, such as drain openings requirements.

4.4.5.7 Awning signs that rely on the mounting surface to prevent water from contacting damp location luminaires, or other non-weatherproof type enclosures, shall be shipped with outdoor, non-hardening caulking.

4.4.5.8 Awning signs shall be provided with a means for attachment to a building, support, or hanging rig.

4.4.6 Section signs

4.4.6.1 General

4.4.6.1.1 Except as noted in [4.4.6.1.6](#), a section sign shall not be shipped for field installation to an existing sign.

4.4.6.1.2 A sign that is designed for shipment as subassemblies must be shipped with all materials and complete instructions for field assembly and wiring and must form a complete sign when assembled and installed in the field. Conduit and connectors for signs rated 1000 V or less are exempt from this requirement.

4.4.6.1.3 All wire, fittings, materials, bushings, or similar devices, shall be provided for joining the segments.

4.4.6.1.4 Except for Class 2 wiring and cable, all required splice compartments shall be provided for all of the conductors to be joined. The compartments shall be accessible for assembly and examination of splices

4.4.6.1.5 A section sign shall be constructed so that when water enters a subassembly or a joint between subassemblies, the water is not capable of contacting components as specified in [5.9.3](#). When required, the subassemblies of a section shall be joined together and subjected to the test described in [5.9.1](#). Field treatment for preventing the entrance of water, such as caulking, is to be disregarded.

4.4.6.1.6 A section of a new sign may be shipped separately if the installation instructions comply with [8.2.1](#) and [8.2.2](#).

4.4.6.1.7 A field installed equipment that derives power from the sign to perform a signage function shall comply with the applicable field wiring requirements of [4.4.6](#).

4.4.6.2 Field-wiring leads

4.4.6.2.1 A field wiring lead 1000 V or less shall be of equipment wire that complies with [3.1.3](#) and is no smaller than 18 AWG (0.82 mm²).

4.4.6.2.2 Strain relief shall be provided on field wiring leads so that stress on a lead will not be transmitted to the electrical connection inside a product. The acceptability of the strain relief means shall be determined by the Strain Relief Test specified in [5.4](#).

4.4.6.3 Grounding and bonding requirements

4.4.6.3.1 Bonding of sections of a section sign to the equipment grounding conductor shall be in accordance with [4.2.4.2](#).

4.4.6.3.2 If a separate external bonding conductor is required it shall be a copper or copper alloy at least 14 AWG (2.1 mm²).

4.4.7 HID signs

4.4.7.1 HID sign spacing

4.4.7.1.1 An HID sign shall comply with the Temperature Test in [5.2](#) unless all of the following are met:

- a) All ballasts, wiring, and similar components are enclosed in metal;
- b) The lamp wattage-per-cubic foot does not exceed 26 W/ft³ (918 W/m³) as determined by the following formula $W/ft^3 = (\text{Total Lamp Watts}) / (\text{Length} \times \text{Width} \times \text{Height})$;
- c) Spacing between a HID lamp and other polymeric material, between a HID lamp and adjacent ballast, or a HID lamp and other components, complies with the clearances of [Table 4.20](#);
- d) A light diffuser/heat barrier does not have openings exceeding 1.9 cm (3/4 in) in any direction and has an opening-to-metal ratio not exceeding 1:1; and
- e) No individual HID lamp exceeds 400 W.

Table 4.20
Minimum clearances between HID lamps and components

Maximum lamp size (W)	Interposed metal light diffuser/heat barrier	Clearances	
		mm	(in)
250 or less	No	229	(9.0)
250 or less	Yes	178	(7.0)
400	No	305	(12.0)
400	Yes	229	(9.0)
A minimum clearance of 610 mm (24 in) is required between an HID lamp and combustible material located directly above the lamp.			

4.4.8 Neon signs for use in dwellings (residential)

4.4.8.1 General

4.4.8.1.1 The requirements in this section apply to self-contained signs employing neon or similar electric discharge lighting intended for use in dwellings or residential installations.

4.4.8.1.2 The requirements in this section are supplemental to all other applicable requirements in this standard and any applicable requirements in the Standard for Neon Transformers and Power Supplies, UL 2161.

4.4.8.1.3 A sign covered by this section shall not employ a mid-point return neon supply with an output voltage exceeding 10 kV (5 kV to ground) with a maximum 15 mA output current, or an end-point return neon supply exceeding 7.5 kV to ground with a maximum 30 mA output current.

4.4.8.1.4 The sign shall employ no user serviceable parts.

4.4.8.1.5 The sign shall not incorporate more than one neon circuit and shall have all neon tubing connected in series.

4.4.8.1.6 Only neon supplies with secondary ground fault protection in compliance with Standard for Neon Transformers and Power Supplies, UL 2161, shall be used.

4.4.8.2 Enclosures

4.4.8.2.1 Except as noted in [4.4.8.2.2](#), all live parts shall be enclosed with no openings provided in the enclosure other than the opening used for the power supply connection when permanently connected to a source of supply.

4.4.8.2.2 Neon transformers and power supplies may be provided with openings provided they comply with [4.4.8.3](#).

4.4.8.3 Accessibility

4.4.8.3.1 All exposed live parts shall be inaccessible to contact. Internal live parts internal to neon transformer or power supply or another other component that is in excess of 15 Vrms in a damp or wet location and 30 V in a dry location shall comply with [5.15](#), Straight Accessibility Probe Test.

4.4.8.3.2 The ventilation openings of a cord connected neon transformer or power supply complying with the accessibility requirements in the Standard for Neon Transformers and Power Supplies, UL 2161, comply with this requirement. Neon transformers and power supplies that comply with the Standard for Neon Transformers and Power Supplies, UL 2161 requirements for permanently connected equipment and are intended for use in dwellings shall additionally comply with the accessibility requirements in this section.

4.4.8.3.3 Where an accessibility barrier is provided to prevent contact with live parts in excess of 1000 Vrms (1414 Vpeak) to ground, the barrier assembly shall comply with [5.11](#), Barrier Accessibility Dielectric Test.

4.4.8.3.4 Other than those components that have been evaluated for use in signs for use in dwellings in accordance with the requirements in [4.4.8](#), all insulated live parts including neon tubing electrode enclosures and GTO sleeveings, shall be inaccessible to contact by the Accessibility Probe, [Figure 4.3](#).

4.4.8.3.5 Except as noted in [4.4.8.3.6](#), the sign body and enclosure shall be constructed with no user-serviceable electrical parts within, and shall be assembled by fasteners that are tamper resistant, such as by one-way fasteners, uniquely keyed screws, rivets, welding or adhesives.

4.4.8.3.6 A neon tubing electrode splice enclosure are considered to be tamper resistant sufficient to be designated for use in dwellings where exposed to contact provided it can withstand without displacement from the proper size of neon tubing, a minimum 133.4 N (30-lbs) straight pull force for one minute without exposing live parts and reducing electrical spacings.

4.4.8.3.7 The electrodes of neon tubing shall be recessed such that they are within either an enclosure, a neon electrode tubing splice enclosure complying with [4.4.8.3.6](#) or within a neon tubing electrode splice enclosure that has not been determined to comply with [4.4.8.3.6](#) and is within a sign body. Except as noted in [4.4.8.3.8](#), the amount of recessing in the enclosure or sign body shall be such that the minimum spacing complies with [Table 4.21](#). The minimum spacing is to be measured between the neon tubing electrode shell and the accessibility probe shown in [Figure 4.3](#), when the probe is positioned into the opening of the enclosure or sign body that remains when the glass of the neon tubing has been removed.

Table 4.21
Spacings between neon electrode and accessibility probe

Transformer or power supply output voltage V	Minimum spacing	
	mm	(in)
1001 – 5000	6.4	(0.25)
5001 – 7500	12.7	(0.50)
7501 – 10,000	12.7	(0.50)

4.4.8.3.8 A neon tubing secondary circuit that is provided with open-circuit protection complying with [4.4.8.4.2](#) is permitted to have the end of the neon electrode shell flush with the enclosure or sign body and be accessible to the accessibility probe as a result of neon tubing breakage.

4.4.8.4 Abnormal operation

4.4.8.4.1 A sign provided with more than one neon circuit having a non-metallic or metallic sign body or enclosure shall be used only when the following conditions are met:

a) Each neon transformer or power supply that incorporates circuitry that is relied upon to comply with other requirements in this outline by interrupting power to the output circuit, shall do so within 500 ms of the existence of an open-circuit condition. Upon opening, the output voltage shall not exceed the voltage accessibility limits specified in [4.4.8.3.1](#).

b) The circuitry responsible for providing the overcurrent protection specified in item (a) shall be capable of normal operation in opening the neon output circuit upon being subjected to the Secondary Ground-Fault Protection Circuit Abnormal Test conditioning and testing criteria specified in the Standard for Neon Transformers and Power Supplies, UL 2161. The conditions of testing include:

- 1) Component fault,
- 2) Thermal aging,
- 3) Overvoltage and undervoltage,
- 4) Power supply interruption,
- 5) Transient surge, and
- 6) Humidity.

4.4.8.4.2 A sign marked for use in dwellings shall either have open circuit protection that complies with [4.4.8.4.1](#) or have:

- a) No more than one neon circuit,
- b) All neon tubing connected in series, and
- c) No metal in the sign body or enclosure.

4.4.8.5 Markings

4.4.8.5.1 Signs covered by this section shall be marked in accordance with [7.8](#).

4.4.9 Rebuilt signs

4.4.9.1 A rebuilt sign shall comply with all of the requirements in this standard.

4.4.9.2 All components that affect compliance determination, whether being replaced or not, shall be identifiable and determined to comply with the applicable current requirements in this standard and any other applicable component standard referenced herein.

4.4.9.3 Ferrous metal parts need only additional corrosion protection if rust is present.

4.4.10 Glass

4.4.10.1 General

4.4.10.1.1 Glass sheets, whether functional or decorative, and smaller than 2540 mm (100 in) in any dimension, shall be either of the double-strength soda lime type, or of the tempered, laminated, or organic-coated type.

4.4.10.1.2 Glass sheets exceeding 2540 mm (100 in) in any dimension shall be of the tempered, laminated, or organic-coated glass type and shall comply with the following:

a) Tempered glass – When broken by the Glass Fragmentation Test in [5.12](#), the glass dices into fragments not larger than 6.5 cm² (1 in²), without splintering or producing sharp edges on any piece.

b) Laminated or organic-coated glass – When broken by the Glass Impact Test in [5.12A](#), the sheets will not be broken, or will not expel pieces of glass greater than 30 g (0.066 lbs) in mass or greater than 50 mm (1.96 inch) in any dimension.

4.4.10.1.3 Edges of glass accessible during normal use or maintenance shall be seamed, swiped, fire polished, or similarly treated to eliminate sharpness.

4.4.10.2 Requirements for glass used as enclosure

4.4.10.2.1 In addition to [4.4.10.1](#), single sheets of soda lime type glass, smooth or otherwise, shall additionally comply with the exposed area and minimum thickness dimensions of [Table 4.22](#).

Table 4.22
Minimum thickness of glass panels and mechanical support means

Exposed area of glass		Thickness of glass				Thickness of clips/troughs				Overlap of clips/troughs	
		Flat glass		Curved glass		Coated steel		Aluminum / copper			
cm ²	(in ²)	mm	(in)	mm	(in)	mm	(in)	mm	(in)	mm	(in)
0 – 968	(0 – 150)	2.11	(0.083)	2.11	(0.083)	0.43	(0.017)	0.51	(0.02)	12.7	(0.5)
969 – 3226	(150 – 500)	2.54	(0.100)	2.11	(0.083)	0.43	(0.017)	0.51	(0.02)	12.7	(0.5)
3227 – 7097	(500 – 1100)	3.56	(0.140)	2.54	(0.100)	0.91	(0.036)	1.09	(0.04)	12.7	(0.5)
7098 – 9316	(1100 – 144)	3.56	(0.140)	2.54	(0.100)	0.91	(0.036)	1.09	(0.04)	12.7	(0.5)

4.4.10.2.2 Areas of glass that are curved, bent, or made into non-flat shapes shall also comply with the minimum thickness dimensions of [Table 4.22](#) for exposed areas exceeding 1774 cm² (275 in²).

4.4.10.2.3 Tempered glass that does not comply with [Table 4.22](#) shall be subjected to the Glass Impact Test in [5.12A](#). If the tempered glass does not comply with the test in [5.12A](#), the tempered glass shall be subjected to the Glass Fragmentation Test in [5.12](#).

4.4.10.2.3.1 Laminated and organic coated glass shall be subjected to the Glass Impact Test in [5.12A](#).

4.4.10.2.4 The minimum thickness of fluted, ribbed, or patterned glass shall be measured from a valley of one side to the other flat side, or between valleys on opposite sides.

4.4.10.2.5 Glass tubing is capable of being used as an enclosure, barrier, and water shield of insulated wiring and electrical connections when the tubing is minimum 2.5-mm (0.1-in) thick and is mechanically secured and supported.

4.4.10.2.6 Glass tubing is capable of being used as an enclosure, barrier, and water shield of GTO cable when the tubing is minimum 2.5-mm (0.1-in) thick and is mechanically secured and supported in place.

4.4.10.3 Support

4.4.10.3.1 Glass shall be secured in place and shall not be subjected to undue strain in normal use or maintenance to result in breakage or release.

4.4.10.3.2 Unless evaluated and found suitable for the application, metal clips/troughs used for support shall comply with [Table 4.22](#).

4.4.10.3.3 Continuous troughs or glazing angles shall be used when the exposed glass area is more than 0.64 m² (1000 in²).

4.4.11 Skeleton neon tubing

4.4.11.1 Skeleton neon tubing sign and outline lighting shall comply with the requirements of Sections [4.2](#), [4.3.17](#), [7.1](#), [7.2](#), [7.6](#), and [8.3](#).

4.4.11.2 Wiring for a skeleton neon tube sign or outline lighting is not required to be complete before it leaves the factory.

4.4.11.3 Neon transformers and power supplies shall be enclosed in a metal enclosure or be of the self-enclosed type.

4.4.11.4 Tube and cable supports fastened to a building mounting surface shall be mechanically secured.

4.4.11.5 Field-installed GTO cable between the transformer enclosure and skeleton tube electrodes shall be enclosed in a raceway. GTO cable emerging from the enclosure at the wall surface, and GTO cable between double-back electrodes shall be enclosed in GTO cable sleeving, other assembly or the GTO cable shall be evaluated for use outside a raceway.

4.4.11.6 Exposed neon tube electrodes shall be enclosed in an enclosure intended for the purpose. Connections shall be mechanically secured.

4.4.11.7 All component parts of a skeleton tubing sign or outline line lighting, except for the skeleton neon tubing shall comply with the requirements for field installed sign components in the Standard for Electric Sign Components, UL 879.

4.4.11.8 Electrode receptacles with an integral outer metal enclosure shall be bonded to the equipment ground.

4.4.11.9 Electrode receptacles that penetrate a building surface in a wet location shall have a cap that complies with the requirements for field installed sign components in the Standard for Electric Sign Components, UL 879, to close the opening between the skeleton neon tubing and receptacle.

4.4.11.10 Readily accessible field-installed skeleton tubing shall be provided with suitable guards for protection against physical damage.

4.4.12 Photovoltaic powered signs

4.4.12.1 Photovoltaic powered signs shall comply with all the requirements in this standard, including [4.4.12.2](#) – [4.4.12.20](#).

4.4.12.2 Photovoltaic powered signs may be provided with combinations of power conversion devices such as dc/ac inverters, photovoltaic charge controllers, or battery chargers. Photovoltaic powered signs may be designed for one of the following modes of operation:

a) Off grid/standalone - All power for sign operation is provided from the photovoltaic source or a battery, and no connection to the ac utility service is provided. A stand-alone inverter may also be provided to service ac loads.

b) On grid/non-utility Interactive - Power for sign operation may be provided from the photovoltaic source, a battery, or the ac utility. A connection to the ac utility service is provided, but an inverter does not supply loads in parallel with the ac utility and an inverter does not supply (export) current or power to the ac utility. A transfer switch may be incorporated to switch loads between the inverter and the ac utility.

c) Utility interactive - Power for sign operation may be provided from the photovoltaic source, an optional battery, or the ac utility. A connection to the ac utility service is provided, and an inverter which complies with the applicable standard specified in [Table 4.23](#) and is marked "Utility Interactive Inverters" or "Grid Support Utility Interactive Inverter" may supply loads in parallel with the ac utility and/or supply current or power to the ac utility.

4.4.12.3 The following components used in photovoltaic powered signs shall comply with the standards indicated in [Table 4.23](#).

Table 4.23
Components used in photovoltaic powered signs

Component	Standards for PV Components								
	UL 1008 ^{a)}	UL 1012 ^{b)}	UL 1236 ^{c)}	UL 1310 ^{d)}	UL 61730 series or UL 1703 ^{e)}	UL 62109 series or UL 1741 ^{f)}	UL 1778 ^{g)}	UL 1973 ^{h)}	UL 2054 ^{i),j)}
Battery chargers powered from ac		X	X	X		X			
Photovoltaic Charge controllers						X			

Table 4.23 Continued on Next Page

Table 4.23 Continued

Component	Standards for PV Components								
	UL 1008 ^{a)}	UL 1012 ^{b)}	UL 1236 ^{c)}	UL 1310 ^{d)}	UL 61730 series or UL 1703 ^{e)}	UL 62109 series or UL 1741 ^{f)}	UL 1778 ^{g)}	UL 1973 ^{h)}	UL 2054 ^{i,j)}
Photovoltaic modules or panels					X				
Rechargeable batteries								X	X
Stand-alone inverters						X			
Stand-alone Inverters which receive power only from a battery		X				X	X		
Transfer switches	X						X		
Utility Interactive inverters						X			
Multiple mode inverters						X			
PV DC/DC Converters						X			
^{a)} The Standard for Transfer Switch Equipment, UL 1008 ^{b)} The Standard for Power Units Other Than Class 2, UL 1012 ^{c)} The Standard for Battery Chargers for Charging Engine-Starter Batteries, UL 1236 ^{d)} The Standard for Class 2 Power Units, UL 1310 ^{e)} The Standard for Photovoltaic (PV) Module Safety Qualification, UL 61730 series of standards, or the Standard for Flat-Plate Photovoltaic Modules and Panels, UL 1703 ^{f)} The applicable standard from the Power Converters for Use in Photovoltaic Power Systems, UL 62109 series of standards, or the Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources, UL 1741. An inverter evaluated to UL 62109 that is intended for connection to the ac utility service shall additionally be evaluated to the utility interactive and or grid support utility interactive requirements of UL 1741. ^{g)} The Standard for Uninterruptible Power Systems, UL 1778 ^{h)} The Standard for Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications, UL 1973 ⁱ⁾ The Standard for Household and Commercial Batteries, UL 2054 ^{j)} Portable lead acid batteries complying with UL 2054 shall additionally comply with the pressure release test of the Standard for Standby Batteries, UL 1989									

4.4.12.4 Components subject to arcing such as switches, fuses, and contactors used in dc circuits operating in excess of LPS or Class 2 limits shall be rated for use in a dc circuit and/or be rated for photovoltaic use.

4.4.12.5 Connectors in circuits operating in excess of LPS or Class 2 limits used to interrupt power from a battery or photovoltaic panel shall be rated for interruption of a dc circuit or photovoltaic use.

4.4.12.6 Photovoltaic modules or panels marked Class 2 or LPS are not to be connected in series or parallel unless evaluated and rated for that configuration.

4.4.12.7 Cables and conductors from the photovoltaic panel or external to the sign housing shall be marked "Photovoltaic Wire", or "Type SW, STW, STOW, or SOW cord". PLTC Cable marked "Sunlight Resistant" or "SUN RES" may be used for systems operating within Class 2 or LPS limits.

4.4.12.8 Cables and conductors from the photovoltaic panel(s) or external to the sign housing shall be kept as short as possible and be routed to closely follow the sign structure and be secured at intervals not exceeding 0.91 m (3 ft).

4.4.12.9 Batteries shall not be connected in series or parallel unless evaluated for that configuration.

4.4.12.10 Openings in a battery enclosure, battery compartment and sign shall be constructed to prevent accumulation of flammable gases that could lead to a hazardous condition from concentrations of hydrogen gas due to electrolysis of aqueous electrolytes for applicable battery technologies, such as vented or valve regulated lead acid and nickel batteries and applicable electrochemical capacitor technologies, greater than 25% of the LFL (Lower Flammable Limit) of hydrogen (equivalent to 1% concentration in a volume of air). Ventilation openings shall have a minimum opening area of:

$$A = 0.005NC_5 (cm^2)$$

Where:

A = Total cross sectional area of ventilation holes required (cm²)

N = Number of cells in battery

C₅ = Capacity of battery at the 5 h rate (Ah)

4.4.12.11 Battery compartments shall require a tool to open.

4.4.12.12 Unless a battery is enclosed in a separate compartment that requires the use of tools to access and does not contain user serviceable parts, the positive terminal of a battery shall be insulated to prevent accidental shorting. An Insulating cover over the positive terminal would be considered to comply.

4.4.12.13 Metal supporting a vented battery with liquid electrolyte shall be suitably protected from corrosion by a means other than paint alone. The use of a battery box constructed of polymeric material with a suitable temperature rating for the application and a flammability rating of HB minimum is considered to meet this requirement.

4.4.12.14 The output leads of the battery pack should be sized and protected in accordance with [Table 4.24](#).

Table 4.24
Size and protection of output leads of a battery pack

Wire size AWG (mm ²)	Maximum overcurrent protective device rating A
20 (0.52)	5
18 (0.82)	10
16 (1.3)	15
14 (2.1)	15
12 (3.3)	20

4.4.12.15 When a fuse or overcurrent protective device is required for the battery pack output leads, the overcurrent protective device shall be installed within 46 cm (18 in) of the battery pack.

4.4.12.16 Fuseholders with exposed contacts (clip type) shall not be accessible by the accessibility probe during user servicing such as changing advertising.

4.4.12.17 The following circuits are considered equivalent to Class 2 or LPS for requirements inside the sign body:

- a) Isolated circuits rated 20 Vdc or less and protected by a calibrated overcurrent device that limits the maximum current to 5 A; or
- b) Circuits rated 30 Vdc or less and protected by a calibrated overcurrent device that limits the maximum current to 3.2 A or less.

4.4.12.18 When a fuse is used to provide the overcurrent protection in accordance with [4.4.12.17](#), it shall be used with a lockout type fuseholder that mechanically prevents the use of a higher current rated fuse.

4.4.12.19 Photovoltaic signs shall comply with the applicable marking requirements of Section [7](#), including the requirements of [7.9](#) that are specific to photovoltaic signs.

4.4.12.20 In addition to complying with the installation instruction requirements in [8.1](#) and [8.2](#), installation instructions for photovoltaic signs shall comply with [8.6](#).

5 Performance

5.1 General

5.1.1 Signs shall be tested in accordance with the manufacturer's instructions.

5.1.2 Adjustable parts shall be positioned to cause maximum heating during the following tests: Temperature, Leakage Current, Abnormal, and Thermal Shock Tests.

5.1.3 For tests that require the unit to be operated, the voltage of the test circuit is to be 120 V when the sign is rated between 110 and 120 V (inclusive), or 240 V when the sign is rated between 220 and 240 V (inclusive). At any other voltage rating, the sign is to be tested at its marked rating. A sign that is rated for use at more than one voltage, or for a range of voltages and contains a tapped transformer or other means of being adapted to different sources of supply, is to be tested at the most unfavorable combination of supply voltage and internal adjustment.

5.2 Temperature

5.2.1 General

5.2.1.1 When tested under the conditions that result in maximum heating, a sign shall not attain a temperature at any point that results in fire, adversely affects any material used, or exhibits temperatures on components/materials in excess of those indicated in [Table 5.1](#), unless the component/material has been investigated and found acceptable for a higher temperature.

Table 5.1
Maximum temperature limits

Component and location	Maximum temperature – thermocouple method		Maximum temperature – change of resistance method	
	°C	(°F)	°C	(°F)
1. Coil of a device employing:				
a) Class 105 (A) insulation system	90	(194)	100	(212)
b) Class 130 (B) insulation system	110	(230)	120	(248)
c) Class 155 (F) insulation system	135	(275)	140	(284)
d) Class 180 (H) insulation system	150	(302)	165	(329)
e) Class 200 (N) insulation system	170	(338)	185	(365)
f) Class 220 (R) insulation system	185	(365)	200	(392)
g) Class 250 insulation system	215	(419)	230	(446)
2. Enclosure of an enclosed and potted coil device employing:				
a) Class 105 insulation system	90	(194)		
b) Class 130 insulation system	110	(230)		
c) Class 155 insulation system	135	(275)		
d) Class 180 insulation system	150	(302)		
3. Capacitors:	90 or component rating	(194 or component rating)		
4. Resistor type ballast	150	(302)		
5. Enclosure of automatic starter for fluorescent lamp	80	(176)		
6. Enclosure of automatic starter for HID lamp	90	(194)		
7. Fuse	90	(194)		
8. Insulated wires and cords:				
a) GTO cable	Component rating	Component rating		
b) RH-10 cable	75	(167)		
c) Other	Component rating	Component rating		
9. Thermoplastic	50 or component rating	(122 or component rating)		
10. Combustible structural building parts for sign support	90	(194)		
11. Gaskets	60 or component rating	(140 or component rating)		
12. Electrical insulating materials				
a) Phenolic	150	(302)		
b) Silicone rubber (not stressed)	200	(392)		
c) Silicone rubber (compressed)	170	(338)		
d) Neoprene rubber (dry locations)	90	(194)		
e) Neoprene rubber (oil or wet locations)	60	(140)		
f) Rubber (ordinary)	60	(140)		

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