



UL 924

STANDARD FOR SAFETY

Emergency Lighting and Power Equipment

UL Standard for Safety for Emergency Lighting and Power Equipment, UL 924

Tenth Edition, Dated May 9, 2016

Summary of Topics

This revision of ANSI/UL 924 dated December 14, 2022 includes the following changes:

- **Scope Clarifications;** [1.4](#), [1.5](#)
- **Definitions;** [4.3](#), [4.19](#)
- **Mounting Means;** [11.1](#), [11.2](#), [Section 70A](#)
- **Installation – wiring connections;** [17.1.1](#) – [17.1.4](#), [17.2.1](#) – [17.2.3](#), [17.3.1](#), [17.3.2](#), [Section 17.5](#), [19.4.4](#)
- **Batteries;** [22.1](#) – [22.2.3](#), [33.1](#), [Section 48A](#), [Section 48B](#), [52.11.1](#)
- **Electronic circuits subject to voltage surge testing;** [23.2](#), [55.1](#), [SE4.7.1](#)
- **Overcurrent protection;** [26.2](#)
- **Definitions and detection thresholds for self-testing/self-diagnostic equipment;** [4.52.1](#), [4.52.2](#), [30.1](#)
- **Maximum permitted time for ELCD operation;** [47.2](#)
- **Temperature test for recessed equipment;** [40.3](#), [52.10](#), [52.17](#), [73A.3.12](#)
- **Markings;** [30.1.1](#), [Sections 44](#), [71](#), [72](#), [73](#), [73A](#), [74.1](#), [74.2](#), [74.7](#) – [74.10](#), [76.6](#)
- **Low frequency inverter battery discharge compliance option;** [78.2.1](#)
- **Expansion of Appendix B content**
- **Emergency Systems; Appendix C**
- **Editorial Corrections;** [18.4.1](#), [20.2](#), [39.1.1](#), [43.5.1](#), [52.2](#), [52.11](#), [Table SD2.1](#) and [SE4.6.1](#)

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 October 21, 2022.

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The Department of Defense (DoD) has adopted UL 924 on November 14, 1982. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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INTRODUCTION

1 Scope

1.1 This Standard applies to emergency lighting and power equipment for use in unclassified locations and intended for connection to branch circuits of 600 volts or less. Such equipment is intended to automatically supply illumination or power or both to critical areas and equipment in the event of failure of the normal supply, in accordance with Article 700 or 701 of the National Electrical Code, NFPA 70, the Life Safety Code, NFPA 101, the Fire Code, NFPA 1, the International Building Code, IBC, and the International Fire Code, IFC.

1.2 Examples of equipment described in [1.1](#) include:

Exit Signs

Emergency Luminaires

Unit Equipment

Central Station Battery Banks

Inverters

Automatic Battery Charging and Control Equipment

Emergency Lighting Control Devices (e.g., Automatic Load Control Relays, Derangement Signals)

1.3 This Standard also applies to auxiliary lighting and power equipment for use in unclassified locations. Auxiliary equipment has not been investigated to determine compliance with the performance requirements of Article 700 or 701 of the National Electrical Code, NFPA 70, the Life Safety Code, NFPA 101, or the International Building Code. Such equipment includes luminaires with an integral battery backup power supply, illuminated directional signs, battery assemblies, and related devices.

1.4 The basic requirements for protection against risk of fire, electric shock, and injury for some equipment within the scope of this standard are addressed in other standards. The primary role of UL 924 in these cases is to validate compliance with emergency system functionality and performance expectations. The investigation of such equipment for UL 924 compliance shall, to the extent practical, adhere to [5.1](#) and [5.2](#) (typically applied to Components). Examples of equipment and their respective safety standards that exhibit this relationship include, but are not limited to, the following:

Luminaires, UL 1598

Low Voltage Lighting Systems, UL 2108

Electric Signs, UL 48

Uninterruptible Power Systems, UL 1778

Energy Storage Systems and Equipment, UL 9540

Branch Circuit Emergency Lighting Transfer Switches, UL 1008

(PoE) Power Source Equipment, UL 60950-1 or UL 62368-1

1.5 Emergency lighting and power equipment intended for installation in Classified (hazardous) Locations, as defined in NFPA 70, shall comply with additional or alternative requirement outside the scope of this standard.

2 References

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

3 Resistance to Environmental Conditions

3.1 Equipment marked with an enclosure type number, such as 4X, shall comply with the following:

- a) The enclosure shall comply with the applicable requirements specified in the Standard for Enclosures for Electrical Equipment, UL 50, and
- b) The equipment shall comply with the requirements in this standard for use in the environment indicated by the enclosure type designation.

4 Glossary

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

4.2 AUTOMATIC BATTERY CHARGING EQUIPMENT – Equipment provided to maintain the central storage battery bank in a charged condition at all times when the normal supply is available.

4.3 AUTOMATIC LOAD CONTROL RELAY – An Emergency Lighting Control Device (ELCD) that switches dimmed or off emergency luminaires to full illumination output when the normal supply fails, and returns the luminaires to the previous status when the normal supply is restored. These devices are not transfer switches, but instead transmit power only from a single upstream source (typically, the emergency source) to specific loads. They connect to a second (typically, the normal) source of power only for monitoring purposes.

4.4 AUXILIARY LIGHTING AND POWER EQUIPMENT – Equipment associated with or related to, but not interconnected with or required as part of a facility's emergency lighting or power system. This equipment is not evaluated for compliance with the minimum output (power or light) requirements of the National Electrical Code, ANSI/NFPA 70, the Life Safety Code, NFPA 101, or the International Building Code, and is so marked.

4.5 BATTERY BANK – An enclosed group of batteries intended to supply power to remote lighting or power equipment.

4.6 CENTRAL STATION BATTERY LIGHTING AND POWER SYSTEMS – Systems intended to supply power for emergency lighting equipment, typically consisting of a central storage battery bank, automatic battery charging equipment, inverters, automatic control relays, multi-circuit distribution equipment, derangement alarm equipment, and other applicable accessories. Such equipment may be integrally housed in a single overall enclosure or may be separately enclosed for remote connection to a central control unit.

4.7 CENTRAL STORAGE BATTERY BANK – Storage batteries arranged and connected so as to provide the required emergency system voltage.

4.8 CLASS 2 CIRCUIT – A circuit supplied by an isolating source that complies with the Standard for Class 2 Power Units, UL 1310 or the Class 2 requirements of either the Standard for Low Voltage

Transformers – Part 1: General Requirements, UL 5085-1 and the Standard for Low Voltage Transformers – Part 3: Class 2 and Class 3 Transformers, UL 5085-3, or the Limited Power Source Test of the Standard for Household and Commercial Batteries, UL 2054.

4.9 COMBINATION UNIT – A single piece of equipment that functions as an Exit Light and as Unit Equipment.

4.10 COMBUSTION – The decomposition of materials from solid to vapor state, through the application of heat, typically evidenced by flames, smoldering, charring, or mechanical deformation.

4.11 COMPOSITE SOLID STATE SWITCH-INVERTER – Electronic switching circuitry that permits an inverter to function in the emergency mode using only the battery supply.

4.12 CONTINUOUS ILLUMINATED LETTER OR DIRECTIONAL INDICATOR – A letter or directional indicator that is continuous over its entire illuminated height, width or stroke width. Up to two structural members, each no more than 0.3 inches (8 mm) in width, may be provided in letters with physically disconnected center sections.

4.13 DERANGEMENT ALARM – An audible or visible (or both) signal to indicate disruption or failure in an emergency power circuit.

4.13.1 DIRECTLY CONTROLLED EMERGENCY LUMINAIRE – A luminaire with ALCR functionality to automatically override any control setting (such as dim or “off”) and restore full (or some other pre-set) illumination level upon loss of normal power. The ALCR functionality can be integral to the luminaire or through a control signal input from a remote ELCD.

4.14 DUTY CYCLE – As applicable to flashing exit fixtures and exit lights, duty cycle refers to the light pulse duration (“on” time) expressed either as a percentage or fraction of the cycle duration or as both the light pulse duration and duration between successive light pulses (“off” time).

4.15 ELECTROLUMINESCENT – The emission of light from a phosphor excited by an electromagnetic field.

4.16 EMERGENCY BALLAST – An assembly with batteries, a charger, high frequency inverter, and ELCD (or ELCF circuit) intended to provide emergency power to one or more fluorescent lamps upon loss of normal power.

4.17 EMERGENCY BATTERY PACK – A term used within this standard to refer to both an emergency ballast and an emergency LED driver.

4.18 EMERGENCY LED DRIVER – An assembly with batteries, a charger, LED driver, and ELCD (or ELCF circuit) intended to provide emergency power to one or more LED lamps or arrays upon loss of normal power.

4.18.1 EMERGENCY LIGHTING CONTROL DEVICE (ELCD) – A separate or integral device intended to perform one or more EMERGENCY LIGHTING CONTROL FUNCTIONS. Upon loss of normal power, an ELCD defaults to a position that does not disrupt the flow of emergency power to any controlled emergency load.

4.18.2 EMERGENCY LIGHTING CONTROL FUNCTION (ELCF) – An activity related to the performance of an emergency lighting system, including but not necessarily limited to one or more of the following:

- a) Sensing normal power status and transmitting a normal power status signal to a separate or integral device;
- b) Interpreting a normal power status signal (receiving and translating to some other type of signal);
- c) Controlling the lighting output level (e.g., changing “off” to “on”; “dim” to “full”);
- d) Distributing emergency power or control signals among connected devices;
- e) Simulating a loss of normal power (for manual testing or self-test/self-diagnostic purposes).

Each function is subject to performance validation in accordance with the Emergency Lighting Control Functionality (ELCF) Test, Section [47](#).

4.19 EMERGENCY LUMINAIRE – An illumination source with:

- a) Two or more lamps intended to be separately connected to a normal and an emergency source of power (no automatic control equipment),
- b) One or more lamps and an integral ELCD, or
- c) An emergency battery pack.

4.20 EXIT FIXTURE – A fixture with one or more lamps intended:

- a) To be permanently connected to only one source of power (normal or emergency) and
- b) To illuminate an integral text or graphical symbol legend.

4.21 EXIT LIGHT – A complete, enclosed unit assembly arranged for permanent connection, with one or more lamps that illuminate an integral text or graphical symbol legend upon failure of the normal power supply. An exit light may have an automatic load control device and may be provided with a storage battery. If a battery is used, a means for charging the battery is included.

4.22 EXIT SIGN – A general term used to refer to an Exit Light, Exit Fixture, and Self-Luminous or Photoluminescent Exit Sign.

4.23 FIELD-WIRING TERMINAL – Any terminal of the equipment as well as any terminal of any component unit (circuit breaker, switch, and the like) in the equipment to which conductors are to be connected in the field.

4.24 FLOOR PROXIMITY EXIT SIGN – An exit sign intended to be mounted with the bottom edge no less than 6 inches (150 mm) and no more than 18 inches (455 mm) above floor grade.

4.25 FULL-SIZE ILLUMINATED LEGEND – A text-based legend whose dimensions conform to [Table 41.2](#), or a graphical symbol legend whose dimensions conform to [Figure 42.2](#) and [Figure 42.3](#).

4.26 GRAPHICAL SYMBOL – A pictorial representation (also known as a pictogram) serving as a non-language based visual indicator of meaning. Graphical symbols within the context of this Standard are as described in the Standard for Fire Safety Symbols, NFPA 170.

4.27 HIGH-FREQUENCY INVERTER – An arrangement of solid-state circuitry designed to convert direct-current power to high-frequency (greater than 800 hertz), alternating current and the voltage required to operate electric discharge lamps.

4.28 ILLUMINANCE – The amount of light imposed on the surface of a material or object, measured in foot-candles or lux.

4.29 INSTALLATION-WIRING LEAD – Any wire lead to which a supply or other wire is intended to be spliced by an installer in the field.

4.30 INSTALLATION-WIRING TERMINAL – Any terminal to which a supply or other wire is intended to be connected by an installer in the field.

4.31 ISOLATED CIRCUIT – A circuit supplied by a source with no direct electrical connection between input and output (such as a transformer or optical isolator). A common grounding means for the input and output does not violate the isolating nature of the source.

4.32 LAMP – A light source of any configuration (e.g., bulb, tube, LED array or module, etc.), replaceable or not, intended to illuminate portions of the equipment (such as a lamp inside an exit sign that illuminates the legend) or to illuminate the environment where the equipment is located (such as the lamps on unit equipment).

4.33 LAMPHEAD – As applicable to unit equipment, a lamp assembly mounted externally to the main enclosure of the equipment with a swivel or equivalent mounting means so as to be adjustable.

4.34 LEGEND – Text (in English or other languages as appropriate for the installation site) or graphical symbols intended to transmit a specific message associated with life safety, in accordance with an adopted building or fire code.

4.35 LIMITING IMPEDANCE CIRCUIT – A circuit supplied by an impedance that, under any load condition including when a direct short is applied across the source output:

- a) Has a calculated power dissipation of 15 W or less, and
- b) Does not incur any opened or shorted components.

The limiting impedance shall additionally function under any single fault condition unless it consists of a single resistor, or of a single capacitor that complies with the Standard for Fixed Capacitors for Use in Electronic Equipment – Part 14: Sectional Specification: Fixed Capacitors for Electromagnetic Interference Suppression and Connection to the Supply Mains, UL 60384-14. See Determination of Limiting Impedance Circuit Status, Section [51](#).

4.36 LOW-FREQUENCY INVERTER – An arrangement of solid-state circuitry designed to convert direct-current power to low-frequency (50 – 800 hertz), alternating current and the voltage required to operate lighting and power equipment.

4.37 LOW-VOLTAGE, LIMITED-ENERGY CIRCUIT – A circuit supplied by a source of open circuit potential below the risk of electric shock and maximum 8 A, or 150/V amps for circuits operating between 30 – 60 Vdc, measured after one minute of operation. See Section [50](#).

4.38 LUMINANCE – The amount of light emitted from a surface, measured in foot-lamberts or candelas per square meter.

4.39 MULTI-CIRCUIT DISTRIBUTION EQUIPMENT – Any multi-circuit distribution panel incorporating individual branch circuit overcurrent protection. This equipment may be provided with individual branch circuit monitoring control relays.

4.40 NON-CONTINUOUS ILLUMINATED LETTER OR DIRECTIONAL INDICATOR – A letter or directional indicator that is not continuous over its entire illuminated height, width, or stroke width. Examples of such constructions are exit signs with a series of point light sources (such as light-emitting diodes – LEDs) or illuminated segments separated from each other by nonluminous (opaque) spaces.

4.40.1 OPEN TYPE DEVICE – A component or subassembly with instructions that limit installation to within enclosures of metal or nonmetallic materials suitable for fire containment and that limits user access to parts representing a risk of electric shock. See [74.9](#).

4.41 OTHER ACCESSORIES – Any equipment that may be provided as a component part of a central station battery lighting and power system, other than remotely connected lighting fixtures (such as battery disconnect switching devices, phase monitor equipment, and the like).

4.42 PHOTOLUMINESCENT – Having the property of emitting light that continues for a length of time after excitation by visible or invisible light has been removed.

4.43 QUALIFIED SERVICE PERSONNEL – Persons trained in the installation and servicing of the product.

4.44 REDUCED-SIZE ILLUMINATED LEGEND – A legend having full size letters in accordance with [41.1](#), the illuminated areas of which are smaller with dimensions between 5-1/2 to 6 inches (139.7 to 152.4 mm) high by 1-1/2 to 2 inches (38.1 to 50.8 mm) wide with a 1/4 to 3/4 inch (6.4 to 19.1 mm) stroke.

4.45 REMOTE LAMP ASSEMBLY – A unit with one or more lamps intended to be connected to unit equipment or central station battery lighting and power systems.

4.46 RETROFIT – An assembly intended to be permanently field installed in existing equipment.

4.47 RISK OF ELECTRIC SHOCK – A risk of electric shock is considered to exist if the open-circuit potential between any two uninsulated parts, or an uninsulated part and ground, is higher than as shown in [Table 4.1](#), and the available current that would flow between the parts, through a 1500-ohm resistance, is more than 5 mA.

Table 4.1
Voltage limits for risk of electric shock

Waveform type ^a	Maximum voltage	
	Dry and damp locations	Wet locations
Sinusoidal ac	30 V _{rms}	15 V _{rms}
Non-sinusoidal ac	42.4 V _{peak}	21.2 V _{peak}
dc ^{b,c}	60 V	30 V
^a For a combined ac + dc waveform, the wet location voltage limit shall be the non-sinusoidal ac limit where the dc voltage is no more than 10.4 V, and shall be (16 + 0.45*dc voltage) V where the dc voltage is between 10.4 V and 30 V. The dry and damp location voltage limit shall be twice these amounts. ^b If the peak-to-peak ripple voltage on a dc waveform exceeds 10 percent of the dc voltage, the waveform shall be considered a combined waveform per footnote a above. ^c DC waveforms interrupted at frequencies between 10 – 200 Hz shall be limited to 24.8 V in dry and damp locations, and 12.4 V in wet locations.		

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

- a) A Class 2 circuit;

- b) An isolated, low-voltage, limited-energy circuit; or
- c) A limiting impedance circuit.

4.49 ROUTINE MAINTENANCE – Periodic tasks to maintain the equipment in proper working order and intended to be performed by other than qualified service personnel. Examples are, replacing fuses (branch-circuit or load-circuit type), replacing light sources, adding water to batteries and checking specific gravity of electrolyte. An enclosure or compartment is not considered subject to routine maintenance activities when it requires a tool for access and is marked per [73A.4.9](#).

4.50 ROUTINE OPERATION – Operation of a test switch located inside or outside the overall enclosure, resetting of switches and circuit breakers, and similar operations.

4.51 SEALED BATTERY/CELL – A battery/cell that has no provision for the addition of water or electrolyte or for external measurement of electrolyte specific gravity.

4.52 SELF-LUMINOUS EXIT SIGN – A sign with an integral legend that is powered continuously by a self-contained energy source other than a battery, such as radioactive tritium gas. Operation of a self-luminous exit sign is independent of external power supplies or other external forms of energy. This definition does not include exit signs dependent upon photoluminescent materials.

4.52.1 SELF-DIAGNOSTIC ONLY EQUIPMENT – Equipment that automatically performs tests not related to its readiness to provide emergency lighting functionality.

4.52.2 SELF-TESTING/SELF-DIAGNOSTIC EQUIPMENT – Equipment that automatically performs tests, and provides visual (or other) reporting on those tests, related to its readiness to provide emergency lighting functionality in accordance with this Standard.

4.53 SERVICE – Tasks intended to be performed on-site by qualified personnel and that requires either a tool to access any compartment or specialized knowledge for performance of the task.

4.54 TRANSLUCENT – The property of letting light through without being transparent. As applicable to exit signs, a luminous surface that is not transparent, but provides the same effect as a translucent material that is illuminated from the back is also considered to be translucent. For example, a composite construction consisting of a transparent material applied over a luminous non-transparent surface as in edge-lighted exit sign constructions is considered to be translucent.

4.55 UNFILTERED – In the context of a luminaire intended to activate a photoluminescent exit sign, the lack of a lens or diffuser that removes any appreciable portion of the UV spectrum.

4.56 UNIT EQUIPMENT – A complete, enclosed unit assembly, consisting of a rechargeable battery, a battery charging means, provisions for one or more lamps either mounted on the equipment or remote or both, and an ELCD (or ELCF circuit) to energize the lamps automatically upon failure of the normal supply. Terminals or leads are provided for the connection of remote lamps.

4.57 VENTED BATTERY/CELL – A battery/cell provided with positive openings that permit free interchange of cell gases with the outside atmosphere.

4.58 VISIBLE – Legible (as pertains to text) and distinguishable from other text or symbols.

5 Components

5.1 Except as indicated in [5.2](#), a component of a product covered by this standard shall comply with the requirements for that component. See Appendix for a list of standards covering components generally used in the products covered by this standard.

5.2 A component need not comply with a specific requirement that:

- a) Involves a feature or characteristic not needed in the application of the component in the product covered by this standard or
- b) Is superseded by a requirement in this standard.

5.3 A component shall be used in accordance with its recognized rating established for the intended conditions of use. Load control devices shall be rated for the type(s) of loads controlled.

5.4 Specific components are recognized as being incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions for which they have been recognized.

5.5 A component not marked with a short-circuit current rating is considered rated for use in a circuit having a maximum available fault current as shown in [Table 5.1](#).

Table 5.1
Assumed maximum short-circuit current rating for unmarked components

Component	Short-circuit current rating, kA
1. Circuit breaker (including GFCI type)	5
2. Clock-operated switch	5
3. Fuseholder	10
4. Lighting fixture (circuit) internal	5
5. Miniature fuse	10 ^a
6. Plug fuse	10
7. Industrial control equipment:	
a) Auxiliary device	5
b) Switches (other than mercury tube type)	5
c) Mercury tube switches rated over 60 amperes or over 250 volts	5
8. Meter socket base	10
9. Photoelectric switches	5
10. Receptacle (other than GFCI type)	10
11. Snap switch	5
12. Terminal block	10
13. Thermostat	5
^a The use of these fuses is limited to 125-volt circuits.	

5.6 The short-circuit current available in the secondary circuit of a transformer rated 10 kVA or less is considered to be 5,000 amperes or less.

5.7 The short-circuit current available on the load side of a 15 ampere current-limiting circuit breaker or Class CC, G, J, RK-1, RK-5, or T fuse is considered to be 5,000 amperes. In a single-phase 120-volt circuit, the short-circuit current available on the load side of a 20 ampere circuit breaker or Class CC, G, J, RK-1, RK-5, or T fuse is considered to be 10,000 amperes or less.

5.8 Emergency power equipment intended for connection to a supply source capable of more than 5,000 amperes capacity shall comply with the requirements for short circuit current ratings for industrial control panels in Supplement SB of the Standard for Industrial Control Panels, UL 508A.

6 Units of Measurement

6.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

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

7 Radioactive Energy Sources

7.1 Self-luminous exit signs utilizing a radioactive material as the energy source are subject to the requirements of the United States Nuclear Regulatory Commission or Agreement State as applied to a generally licensed device.

CONSTRUCTION

8 Frame and Enclosure

8.1 General

8.1.1 A frame and enclosure shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it is likely to be subjected, without increasing the risk of fire, electric shock, or injury to persons due to total or partial collapse, with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

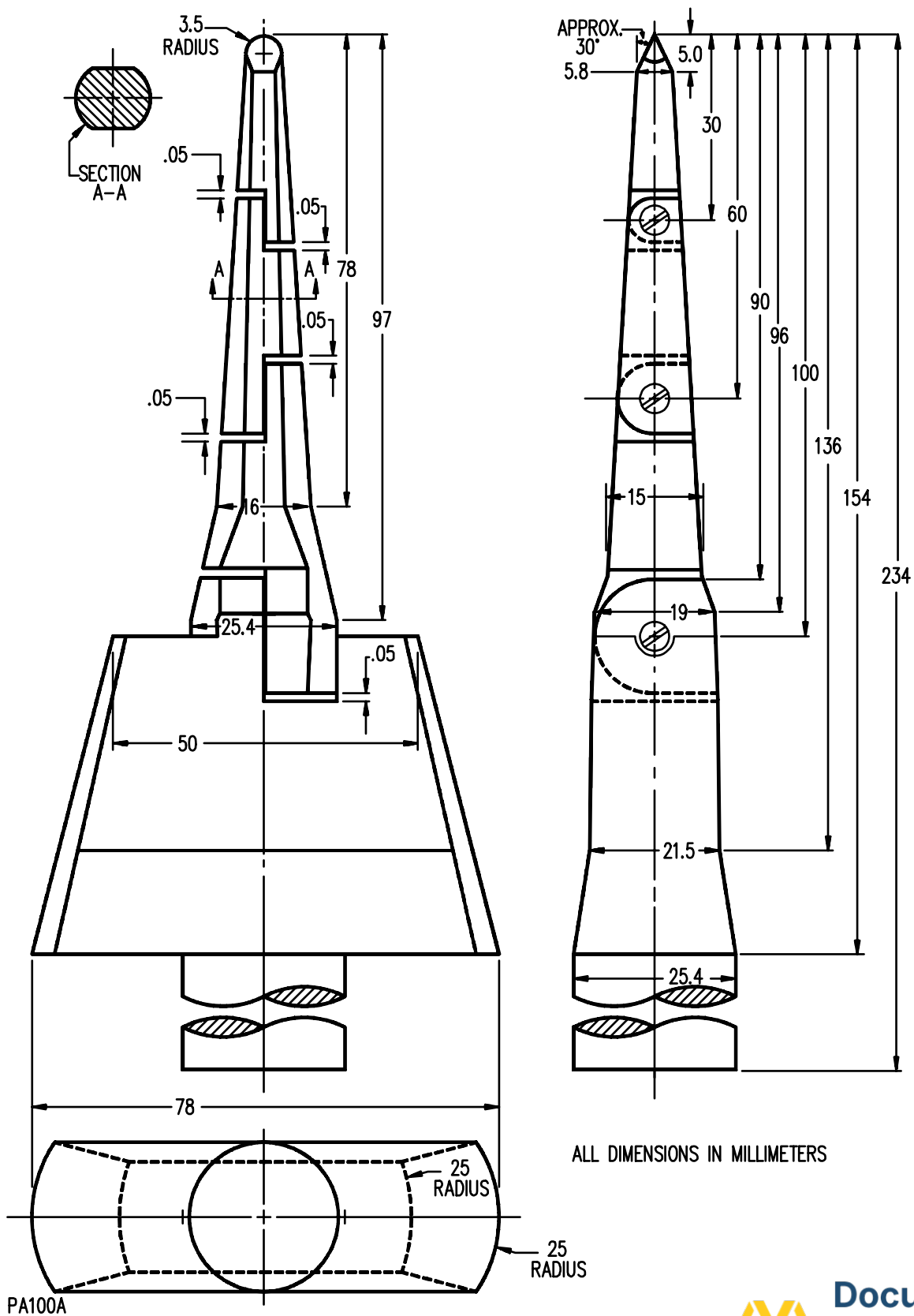
8.1.2 An operating part, such as a relay and similar devices, shall be protected against dust or other material that may adversely affect the intended operation.

8.2 Uninsulated live parts

8.2.1 Uninsulated electrical parts that pose a risk of electric shock shall be located or enclosed such that they are not able to be contacted by the probe illustrated in [Figure 8.1](#), with the probe articulated into any configuration and rotated or angled to any position before, during, or after insertion into the area being investigated.

Exception: Open type devices (see [4.40.1](#)).

Figure 8.1
Articulate probe with web stop



8.2.2 An uninsulated live part considered to be a source of electric shock in a compartment that is intended to be opened for routine maintenance or routine operation shall be located or guarded so as to reduce the risk of inadvertent contact with such a part. Any barrier or guard provided to shield a live part during routine maintenance or routine operation shall remain in place while applying the probe for the purpose of this requirement.

Exception: This requirement does not apply to the lamp contacts of a lampholder or automatic starter holder to which a lamp or automatic starter connects.

8.3 Metallic enclosures

8.3.1 The thickness of a sheet metal enclosure shall be as indicated in [Table 8.1](#) or [Table 8.2](#). These Tables are based on a uniform deflection of the enclosure surface for any given load concentrated at the center of the surface regardless of metal thickness.

Exception No. 1: The enclosure thickness for unit equipment exit signs and luminaires is permitted to be in accordance with the Standard for Luminaires, UL 1598.

Exception No. 2: Lesser thicknesses may be used if the construction is shown by investigation to provide equivalent mechanical strength.

Table 8.1
Minimum thickness of sheet metal for electric enclosures carbon steel or stainless steel

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness			
Maximum width, ^b		Maximum length, ^c		Maximum width, ^b		Maximum length, ^c	
inches	(cm)	inches	(cm)	inches	(cm)	inches	(cm)
4.0	(10.2)	Not limited		6.25	(15.9)	Not limited	
4.75	(12.1)	5.75	(14.6)	6.75	(17.1)	8.25	(21.0)
6.0	(15.2)	Not limited		9.5	(24.1)	Not limited	
7.0	(17.8)	8.75	(22.2)	10.0	(25.4)	12.5	(31.8)
8.0	(20.3)	Not limited		12.0	(30.5)	Not limited	
9.0	(22.9)	11.5	(29.2)	13.0	(33.0)	16.0	(40.6)
12.5	(31.8)	Not limited		19.5	(49.5)	Not limited	
14.0	(35.6)	18.0	(45.7)	21.0	(53.3)	25.0	(63.5)
18.0	(45.7)	Not limited		27.0	(68.6)	Not limited	
20.0	(50.8)	25.0	(63.5)	29.0	(73.7)	36.0	(91.4)
22.0	(55.9)	Not limited		33.0	(83.8)	Not limited	
25.0	(63.5)	31.0	(78.7)	35.0	(88.9)	43.0	(109.2)
25.0	(63.5)	Not limited		39.0	(99.1)	Not limited	
29.0	(73.7)	36.0	(91.4)	41.0	(104.1)	51.0	(129.5)
33.0	(83.8)	Not limited		51.0	(129.5)	Not limited	
35.0	(88.9)	47.0	(119.4)	54.0	(137.2)	66.0	(167.6)
42.0	(106.7)	Not limited		64.0	(162.6)	Not limited	
47.0	(119.4)	59.0	(149.9)	68.0	(172.7)	84.0	(213.4)
52.0	(132.1)	Not limited		80.0	(203.2)	Not limited	

Table 8.1 Continued on Next Page

Table 8.1 Continued

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness	
Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	Maximum width, ^b inches (cm)	Maximum length, inches (cm)	Uncoated, inches (mm)	Zinc coated, inches (mm)
60.0 (152.4)	74.0 (188.0)	84.0 (213.4)	103.0 (261.6)		
63.0 (160.0)	Not limited	97.0 (246.4)	Not limited	0.123 (3.12)	0.126 (3.20)
73.0 (185.4)	90.0 (228.6)	103.0 (261.6)	127.0 (322.6)		

^a A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has such torsional rigidity as to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

- 1) A single sheet with single formed flanges (formed edges);
- 2) A single sheet which is corrugated or ribbed; and
- 3) An enclosure surface loosely attached to a frame, for example, with spring clips.

^b The width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^c For panels not supported along one side (for example, side panels of boxes), the length of the unsupported side shall be limited to the dimensions specified.

^d At point of connection for wiring systems, minimum 0.026 inch (0.66 mm) for uncoated and minimum 0.029 inch (0.74 mm) for zinc coated.

Table 8.2
Minimum thickness of sheet metal for electric enclosures aluminum, copper, or brass

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness, inch (mm)
Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	Maximum width, ^b inches (cm)	Maximum length, inches (cm)	
3.0 (7.6)	Not limited	7.0 (17.8)	Not limited	0.023 ^d (0.58 ^d)
3.5 (8.9)	4.0 (10.2)	8.5 (21.6)	9.5 (24.1)	
4.0 (10.2)	Not limited	10.0 (25.4)	Not limited	0.029 ^d (0.74 ^d)
5.0 (12.7)	6.0 (15.2)	10.5 (26.7)	13.5 (34.3)	
6.0 (15.2)	Not limited	14.0 (35.6)	Not limited	0.036 (0.91)
6.5 (16.5)	8.0 (20.3)	15.0 (38.1)	18.0 (45.7)	
8.0 (20.3)	Not limited	19.0 (48.3)	Not limited	0.045 (1.14)
9.5 (24.1)	11.5 (29.2)	21.0 (53.3)	25.0 (63.5)	
12.0 (30.5)	Not limited	28.0 (71.1)	Not limited	0.058 (1.47)
14.0 (35.6)	16.0 (40.6)	30.0 (76.2)	37.0 (94.0)	
18.0 (45.7)	Not limited	42.0 (106.7)	Not limited	0.075 (1.91)
20.0 (50.8)	25.0 (63.5)	45.0 (114.3)	55.0 (139.7)	
25.0 (63.5)	Not limited	60.0 (152.4)	Not limited	0.095 (2.41)
29.0 (73.7)	36.0 (91.4)	64.0 (162.6)	78.0 (198.1)	
37.0 (94.0)	Not limited	87.0 (221.0)	Not limited	0.122 (3.10)
42.0 (106.7)	53.0 (134.6)	93.0 (236.2)	114.0 (289.6)	

Table 8.2 Continued on Next Page

Table 8.2 Continued

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness,
Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	Maximum width, ^b inches (cm)	Maximum length, inches (cm)	
52.0 (132.1)	Not limited	123.0 (312.4)	Not limited	0.153 (3.89)
60.0 (152.4)	74.0 (188.0)	130.0 (330.2)	160.0 (406.4)	

^a A supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has such torsional rigidity as to resist the bending moments which may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels. Construction considered to be without supporting frame includes:

- 1) A single sheet with single formed flanges (formed edges);
- 2) A single sheet which is corrugated or ribbed; and
- 3) An enclosure surface loosely attached to a frame, for example, with spring clips.

^bThe width is the smaller dimension of a rectangular sheet metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^c For panels not supported along one side (for example, side panels of boxes), the length of the unsupported side shall be limited to the dimensions specified.

^d At point of connection for wiring systems, minimum 0.036 inch (0.91 mm).

8.3.2 The thickness of a cast metal enclosure shall be as indicated in [Table 8.3](#).

Exception: Cast metal of lesser thickness may be used if, upon investigation (consideration being given to the shape, size, and function of the enclosure), it is found to have equivalent mechanical strength.

Table 8.3
Thickness of cast metal enclosures

Use, or dimension of area involved	Minimum thickness	
	Die-cast metal, ^a inch (mm)	Cast metal other than die-cast-type, inch (mm)
Area of 24 square inches (155 cm ²) or less having no dimension greater than 6 inches (152 mm)	1/16 ^b (1.6)	1/8 (3.2)
Area greater than 24 square inches or having any dimension greater than 6 inches	3/32 (2.4)	1/8 (3.2)
At a threaded conduit hole	1/4 (6.4)	1/4 (6.4)
At an unthreaded conduit hole	1/8 (3.2)	1/8 (3.2)

^a Die-cast metal may be used if, upon investigation, it is found to have such mechanical strength as to withstand conditions likely to be encountered in service.

^b The area limitations for metal 1/16 inch (1.6 mm) thick may be obtained by the provision of reinforcing ribs subdividing a larger area.

8.4 Nonmetallic enclosures

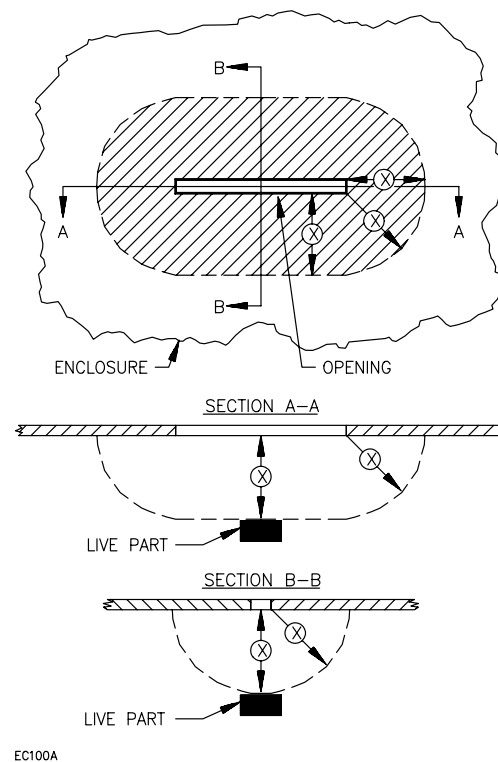
8.4.1 An enclosure made of a polymeric material shall comply with the requirements specified in Polymeric Materials, Section [10](#).

8.5 Enclosure openings

8.5.1 A ventilating opening in an enclosure, including a perforated hole, louver, and an opening protected by means of wire screening, expanded metal, or perforated cover, that has a minor dimension of less than 1 inch (25.4 mm) is acceptable if a probe as illustrated in [Figure 8.1](#), inserted through the opening, cannot be made to touch any uninsulated live part or film-coated wire that involves the risk of electric shock. The probe shall be applied in all possible articulated positions before, during, and after insertion.

8.5.2 An opening of a type as described in [8.5.1](#) that has a minor dimension of 1 inch (25.4 mm) or larger in an enclosure, as illustrated in [Figure 8.2](#), is acceptable if, within the enclosure, there is no uninsulated live part or film-coated wire less than R distance from the inside edge of the perimeter of the opening and X distance from the plane of the opening. T equals the enclosure thickness, R equals X minus T, and X equals 5 times the diameter of the largest round rod that can be inserted through the opening but no less than 6-1/16 inches (154 mm).

Figure 8.2
Opening in enclosure



8.5.3 The thickness of perforated sheet steel and sheet steel used for expanded-metal mesh shall be in accordance with the values in [Table 8.4](#).

Exception: The thickness of expanded steel mesh may be less than specified in [Table 8.4](#), but no less than specified in [Table 8.5](#), if:

a) The indentation of a guard or enclosure will not:

1) Alter the clearance between uninsulated movable live parts and grounded metal, such that performance would be adversely affected or

2) Reduce spacings below the minimum values given in [38.1.1](#) – [38.2.6](#); and

b) Either:

1) Exposed mesh or any one side or surface of the protected device has an area of no more than 72 square inches (465 cm²) and has no dimensions greater than 12 inches (305 mm) or

2) The width of a protected opening is no greater than 3-1/2 inches (89 mm).

Table 8.4
Minimum thickness of expanded metal mesh

Openings	Uncoated,		Zinc-coated,	
	inch	(mm)	inch	(mm)
Maximum 1/2 square inch (3.23 cm ²)	0.042	(1.07)	0.045	(1.14)
More than 1/2 square inch	0.080	(2.03)	0.084	(2.13)
NOTE – In accordance with 8.5.3 .				

Table 8.5
Minimum thickness of expanded metal mesh

Uncoated,		Zinc-coated,	
inch	(mm)	inch	(mm)
0.020	(0.51)	0.024	(0.61)
NOTE – In accordance with conditions given in the Exception to 8.5.3 .			

8.5.4 The wires of screen shall be no smaller than 16 AWG (1.3 mm²) if the screen openings are 1/2 square inch (3.23 cm²) or less in area, and shall be no smaller than 12 AWG (3.3 mm²) for larger screen openings.

8.5.5 An enclosure housing a fuse or any other overload protective device and provided with a ventilating opening shall afford protection against the emission of flame or molten metal.

8.5.6 An enclosure of an electrical part that presents a risk of fire shall not have unused openings through which molten or burning particles could pass directly to the floor or to the mounting surface. This may be accomplished by the use of a barrier or baffle that is resistant to combustion. An opening for battery compartment ventilation, if provided, shall be located so that it will not vent into concealed spaces of a building structure when the equipment is installed as intended.

Exception No. 1: Surface mounted emergency luminaires, unit equipment, and exit signs that comply with the enclosure opening requirements for surface mounted luminaires in the Standard for Luminaires, UL 1598, are permitted.

Exception No. 2: An enclosure that can only be mounted directly over an outlet box may have unused opening(s) facing the mounting surface, when all such openings fall within the 2-inch (50.8 mm) wide by 3 inches (76.2 mm) high, cross-sectional area of the smallest standard, single, gang-box pattern.

8.6 Enclosure covers

8.6.1 An enclosure cover shall be hinged if:

- a) It gives access to a fuse or any other overload protective device the intended functioning of which requires renewal or resetting or
- b) It is necessary to open the cover in connection with the routine operation or routine maintenance of the unit.

Exception: A cover, panel, door, or other part of the enclosure that, by its function or size, obviously must be in place to complete the overall enclosure need not be hinged.

8.6.2 A hinged cover shall be provided with a positive means for latching, such as a spring latch, a magnetic latch, a dimple, or any other mechanical arrangement that will hold the cover in place and that would require some effort on the user's part to open. Gravity alone is not considered to be a positive means for holding the cover in place.

9 Environmental Rating

9.1 An enclosure shall not be marked with a type designation unless it has been determined to comply with the requirements applicable to that designation(s) as specified in the Standard for Enclosures for Electrical Equipment, UL 50.

9.2 An enclosure shall not be marked "raintight," "rainproof," "watertight," or with other similar terms suggesting suitability for specific environmental conditions, unless the enclosure has been determined to comply with the requirements applicable to the corresponding type designation(s) specified in the Standard for Enclosures for Electrical Equipment, UL 50.

9.3 The integrity of an enclosure marked with a type designation shall not be compromised by the introduction of openings or by the penetration of unevaluated fittings or component parts through the enclosure wall. Only fittings or component parts that have been evaluated and marked with a type designation equal to or better than that of the enclosure shall be used and installed in accordance with the part manufacturer's instructions. The enclosure type designation shall be removed in all other circumstances unless the completed assembly is reevaluated and found to comply with the applicable requirements in the Standard for Enclosures for Electrical Equipment, UL 50.

9.4 Equipment intended for use in damp or wet locations shall be evaluated for compliance with Supplements [SB](#) or [SC](#), as applicable.

10 Polymeric Materials

10.1 General

10.1.1 Polymeric materials used for the purposes covered by [10.2](#) – [10.6](#) shall comply with the applicable requirements of this section. When a material is used for more than one purpose, compliance with all relevant properties is required. Materials that have not been identified as conforming to any required performance characteristic shall comply with the applicable alternative evaluation program of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

10.1.2 When there are any uninsulated live parts that represent a risk of fire located within 0.032 inches (0.8 mm) of a polymeric material covered by this section, the material shall additionally have hot-wire ignition (HWI) and high-current arc resistance to ignition (HAI) ratings of 3 or less.

10.1.3 When there are any arcing parts, such as unenclosed switch contacts, located within 0.5 inches (13 mm) of a polymeric material covered by this section, the material shall additionally have a hot-wire ignition (HWI) rating of 3 or less.

10.2 Enclosures

10.2.1 A polymeric enclosure that serves to contain a risk of fire or limit access to a risk of electric shock shall:

- a) Have a minimum 5VA flammability rating for fixed or stationary equipment, or minimum V-2 rating for portable auxiliary equipment;
- b) Have a mechanical or generic temperature index equal to or greater than the maximum temperature measured on the part during the normal temperature test;
- c) Comply with the Resistance to Impact requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. Equipment marked for use in ambients of 0°C (32°F) or below are subject to the cold conditioning prior to impact at 5°C below the marked low ambient temperature. Equipment marked for use in ambients no less than 5°C are subject to the cold conditioning prior to impact at their lowest rated ambient temperature;
- d) Comply with the Mold Stress-Relief Distortion requirements of UL 746C when molded or constructed of formed thermoplastic;
- e) Comply with the UV Light Exposure requirements of UL 746C when the product is intended for (outdoor) wet locations or contains internal fluorescent light sources.

10.2.2 Snap-fit parts are permitted to become dislodged as a result of the impact test of [10.2.1\(c\)](#) if they are able to be properly reattached to the product without the use of tools.

10.2.3 An enclosure intended for connection to rigid metallic conduit (such as products provided with circular openings or knockouts) shall comply with the Polymeric Enclosure Rigid Metallic Conduit Connection Tests of the Standard for Enclosures for Electric Equipment, UL 50.

10.2.4 An enclosure intended for use with rigid non-metallic conduit – cemented or threaded – shall comply with the applicable requirements in Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C.

10.2.5 When an enclosure is provided with knockouts but has not been evaluated in accordance with both [10.2.3](#) and [10.2.4](#), appropriate information shall be provided in the installation instructions as described in [76.5](#).

10.3 Mechanical support

10.3.1 A polymeric part used to suspend another part, the failure of which would result in a risk of fire or electric shock, shall have a mechanical or generic temperature index equal to or greater than the maximum temperature measured on the part during the normal temperature test.

10.3.2 A polymeric part used to suspend another part that weighs more than 2 lbs (0.9 kg) shall comply with the Mechanical Support Static Load Test, Section [69](#).

10.4 Barriers

10.4.1 A polymeric material used as a barrier shall:

- a) Have a mechanical or generic temperature index equal to or greater than the maximum temperature measured on the part during the normal temperature test;

b) Comply with the Mold Stress-Relief Distortion requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C when molded or constructed of formed thermoplastic; and

c) Comply with the Barrier Strength Test, Section [70](#).

10.5 Grounding or bonding means

10.5.1 A polymeric material that affects the integrity of a grounding or bonding means shall:

a) Have a mechanical or generic temperature index equal to or greater than the maximum temperature measured on the part during the normal temperature test; and

b) Comply with the Mold Stress-Relief Distortion requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C followed by the Grounding Continuity Test of Section [63](#) when molded or constructed of formed thermoplastic.

10.6 Structural support

10.6.1 A polymeric material that is relied upon for providing structural support related to compliance with the performance requirements of this Standard shall:

a) Have a mechanical or generic temperature index equal to or greater than the maximum temperature measured on the part during the normal temperature test;

b) Comply with the Mold Stress-Relief Distortion requirements of the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C when molded or constructed of formed thermoplastic; and

c) Be subjected to the Resistance to Impact test of UL 746C. Results shall be considered complying if the relevant performance feature of the end-product is not significantly impaired.

11 Mounting Means

11.1 Equipment that weighs less than 100 lbs (45 kg), and not intended to be placed at grade level or on a rack (or shelf), shall be provided with mounting means that requires the use of tools for relocation. Keyhole slots for mounting screws comply if there is at least one round hole sized or all screwheads will be accessible for tightening during installation.

11.2 Wall or ceiling-mounted equipment (surface or recessed) that weighs more than 50 lbs (22.5 kg) shall be provided with special mounting hardware and comply with the Mounting Means Test of Section [70A](#).

12 Corrosion Resistance

12.1 Iron and steel parts shall be made resistant to corrosion by enameling, galvanizing, sherardizing, plating, or equivalent means. This requirement applies to all enclosure cases whether of sheet steel or cast iron, and to all springs and other parts upon which intended mechanical operation may depend. Bearing surfaces should be of such materials and design as to inhibit binding due to corrosion.

Exception: The following need not be made corrosion-resistant:

a) A bearing, and the like, where such protection is impracticable;

b) A minor part (such as a washer, a screw, a bolt, and the like) if the malfunction of such an unprotected part would not be likely to result in a risk of fire, electric shock, injury to persons, or result in adverse operation of the equipment; and

c) A part made of stainless steel (polished or treated if necessary).

12.2 The interior of a storage battery compartment shall be protected so that it will not be adversely affected by contact with the electrolyte.

Exception: A compartment for a sealed battery need not be so protected.

13 Insulation Material

13.1 An uninsulated live part shall be mounted on material of porcelain or phenolic composition, or on an equivalent insulation material.

13.2 Vulcanized fiber used as an insulation bushing, washer, separator, or barrier, shall not also serve as the sole mechanical support for an uninsulated live part if shrinkage, current leakage, or warpage would degrade its mechanical support or insulating capabilities.

13.3 A countersunk live part shall be covered to a depth of not less than 1/8 inch (3.2 mm) with a waterproof insulation compound that will not soften at a temperature 15°C (27°F) higher than the maximum intended operating temperature of the assembly, and not less than 90°C (194°F) in any case. The softening point of the compound shall be determined by the Standard Test Methods for Softening Point by Ring-and-Ball Apparatus, ASTM E28.

14 Mounting of Parts

14.1 All parts of equipment shall be mounted in position and prevented from loosening or turning, if such movement may interfere with the intended performance of the equipment, or may result in a risk of fire, electric shock, or injury to persons.

14.2 Adhesive-secured parts shall be investigated for compliance with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C if loosening of the part(s) could cause a risk of fire or electric shock, or result in the equipment being unable to function as required by this Standard. The initial (as received) adhesive strength shall be four times the force applied to the part during normal operation (four times the weight of the part if only subjected to gravitational forces). The “reduced number of specimens” program of UL 746C shall be considered for this evaluation.

14.3 An uninsulated live part, other than a pressure wire connector as covered in [37.1.7](#), shall be secured to its supporting surface so that it will be prevented from turning or shifting in position if such movement may result in a reduction of spacings to less than those indicated in [Table 37.1](#). The security of contact assemblies shall be such as to provide continued alignment of contacts.

14.4 The means for preventing the turning, loosening, or shifting of a part, as required in [14.1](#) and [14.3](#), shall consist of more than friction between surfaces – for example, a lock washer, correctly applied, is considered an equivalent means for preventing the turning of a small stem-mounted switch or other device having a single-hole mounting means.

14.5 Lampheads that are subject to pulling or torsional forces during unpacking, installation, maintenance, or service shall comply with the Swivel Torsion and Pull Test, Section [65](#).

15 Operating Mechanisms

15.1 A part of an operating mechanism shall be constructed of material that has the mechanical strength to withstand the stresses of intended use.

15.2 The assembly of an operating mechanism shall be such that it will not be adversely affected by any condition of intended operation.

15.3 A moving part (lamphead swivel, hinge, and the like) shall have sufficient play at bearing surfaces to restrict binding.

15.4 Provision shall be made so that an adjusting screw or similar adjustable part will not loosen under the conditions of intended use.

15.5 An electromagnetic device shall be designed so as to provide positive electrical and mechanical performance under all conditions of intended operation.

16 Current-Carrying Parts

16.1 A current-carrying part shall have sufficient mechanical strength and ampacity for the intended service.

16.2 A bearing, hinge, or the like shall not be used for carrying current between fixed and moving parts.

17 Installation – Wiring Connections

17.1 General

17.1.1 Emergency lighting equipment shall be provided with either lead wires or wiring terminals.

Exception No. 1: See [18.1.3](#).

Exception No. 2: Equipment supplied by communication cables with RJ45 fittings (i.e., PoE) and whose installation instructions declare it to be installed where access to the supply connection is restricted to authorized personnel is permitted to use appropriately configured ports to serve as the supply wire terminals.

17.1.2 Deleted

17.1.3 Equipment shall have provision for the connection of one of the wiring systems required for the equipment. Field drilling of the enclosure for connection of a raceway is permitted if the instructions specifically identify an area suitable for drilling.

17.1.4 Field wiring connections for emergency circuits shall be physically separated, either by location or by barriers, from connections for normal power circuits. If no barrier is provided, separation shall be minimum 1/2 inch (12.7 mm). If a barrier is relied upon, it shall be of metal or a polymeric material that complies with [10.4](#).

17.2 Wiring terminals

17.2.1 Wiring terminals shall provide a secure connection and be prevented from turning. Soldering lugs or solderless (pressure) wire connectors shall be used for larger than 10 AWG (5.3 mm²) wire. Smaller

wires are permitted to use a clamp or a binding screw with a terminal plate having upturned lugs, or the equivalent.

17.2.2 Supply wiring terminals shall be sized to accommodate 60°C (140°F) rated wire, corresponding to the ampere ratings of the equipment. Wiring terminals intended for the connection of remote loads, other than class 2, shall be marked to indicate the required wire size or be sized to accommodate at least one size larger than required for the ampere.

17.2.3 A wire-binding screw to which field-wiring connections are made shall be no smaller than no. 6 (3.5 mm major diameter) for 14 AWG (2.1 mm²) or smaller wire, and no smaller than No. 8 (4.2 mm major diameter) for larger than 14 AWG wire.

17.2.4 A terminal plate tapped for a wire-binding screw shall be of metal no less than 0.050 inch (1.27 mm) thick and shall have no fewer than two full threads in the metal.

Exception: A terminal plate less than 0.050 but no less than 0.030 inch (0.76 mm) thick may be used if the tapped threads are determined to have equivalent mechanical strength.

17.2.5 A terminal plate formed from stock having the minimum required thickness, as given in [17.2.4](#), may have the metal extruded at the tapped hole for the wire-binding screw so as to provide two full threads.

17.2.6 A wire-binding screw shall thread into metal.

17.3 Field-wiring leads

17.3.1 Field-wiring leads provided for splice connections shall be:

- a) No less than 6 inches (152 mm) free length,
- b) No smaller than 18 AWG (0.82 mm²), and
- c) Rated for the current, voltage, temperature, and conditions of use (dry, damp, or wet locations) to which they will be subjected.

17.3.2 *Deleted*

17.4 Polarity identification

17.4.1 A field-wiring terminal for connection of a grounded power supply conductor shall be of, or plated with, a metal white in color. Such a terminal shall be distinguishable from the other terminals, or identification of that terminal shall be shown in some other manner, such as on a wiring diagram adjacent to the terminal.

17.4.2 The surface of a lead intended for field connection of a grounded power supply conductor shall be white or gray, and that lead shall be distinguishable from the other leads.

17.4.3 The color-coding requirement in [17.4.2](#) does not apply to internal wiring that is not visible in a wiring compartment in which field connections are to be made.

17.4.4 In equipment having a rating more than 51 volts and intended to be connected to a grounded supply circuit, and using a lampholder of the Edison screw-shell type, or a single-pole switch or overcurrent protective device other than an automatic control, one terminal or lead shall have identification for the connection of the grounded conductor of the supply circuit. That terminal or lead shall be the one

that is connected to screw shells of lampholders and not to any switch or overcurrent protective device of the single-pole type.

17.4.5 With regard to the requirement in [17.4.4](#), an automatic control is considered to be a device having automatic resetting contacts that are normally closed and having no means for manual control.

17.5 Termination of wiring systems

17.5.1 Deleted

17.6 Knockouts

17.6.1 The requirements specified in [17.6.2](#) – [17.6.6](#) apply to knockouts intended for field connection of a wiring system in accordance with the National Electrical Code, ANSI/NFPA 70.

17.6.2 A knockout in a metal enclosure shall be secured in place, but shall be removable in accordance with the manufacturer's instructions without deformation of the enclosure that would result in damage to electrical components or reduction in electrical spacings.

17.6.3 A knockout in a metal or polymeric enclosure shall remain in place when tested as described in the Security of Knockout Test, Section [64](#).

17.6.4 The diameter of a knockout shall be as specified in [Table 17.1](#) for the trade size conduit or cable fitting intended to be used.

17.6.5 A knockout shall be provided with a flat area surrounding the opening for seating of a conduit bushing and be located so that installation of a bushing at any knockout likely to be used during installation will not result in spacings between uninsulated live parts and the bushing of less than those required by this standard.

17.6.6 In measuring a spacing between an uninsulated live part and a bushing installed in a knockout, it is to be assumed that a bushing having the dimensions indicated in [Table 17.1](#) is in place, in conjunction with a single locknut installed on the outside of the enclosure.

Table 17.1
Knockout or hole sizes and dimensions of bushings

Trade size of conduit				Bushing dimensions			
Nominal size, inches	Outside diameter, (mm)			Overall diameter,		Height,	
		Knockout or hole diameter, inches	(mm)	inches	(mm)	inches	(mm)
1/2	(21.3)	7/8	(22.2)	1	(25.4)	3/8	(9.5)
3/4	(26.7)	1-3/32	(27.8)	1-15/64	(31.4)	27/64	(10.7)
1	(33.4)	1-23/64	(34.5)	1-19/32	(40.5)	33/64	(13.1)
1-1/4	(42.2)	1-23/32	(43.7)	1-15/16	(49.2)	9/16	(14.3)
1-1/2	(48.3)	1-31/32	(50.0)	2-13/64	(56.0)	19/32	(15.1)
2	(60.3)	2-15/32	(62.7)	2-45/64	(68.7)	5/8	(15.9)
2-1/2	(73.0)	3	(76.2)	3-7/32	(81.8)	3/4	(19.1)

Table 17.1 Continued on Next Page

Table 17.1 Continued

Trade size of conduit		Bushing dimensions					
Nominal size, inches	Outside diameter, (mm)	Knockout or hole diameter,		Overall diameter,		Height,	
		inches	(mm)	inches	(mm)	inches	(mm)
3	(88.9)	3-5/8	(92.1)	3-7/8	(98.4)	13/16	(20.6)
3-1/2	(101.6)	4-1/8	(104.8)	4-7/16	(112.7)	15/16	(23.8)
4	(114.3)	4-5/8	(117.5)	4-31/32	(126.2)	1	(25.4)
4-1/2	(127.0)	5-1/8	(130.2)	5-35/64	(140.9)	1-1/16	(27.0)
5	(141.3)	5-5/8	(142.9)	6-7/32	(158.0)	1-3/16	(30.2)
6	(168.3)	6-3/4	(171.5)	7-7/32	(183.4)	1-1/4	(31.8)

18 Cord-Connected Unit Equipment and Luminaires

18.1 General

18.1.1 Flexible cord for connection to the supply circuit is permitted on emergency lighting unit equipment having integral lampheads only, rated at no more than 18 amperes, 277 volts, and constructed in accordance with the requirements in [18.1.1](#) – [18.8.6](#) and applicable requirements elsewhere in this standard. See [74.8](#).

18.1.2 Flexible cord for connection to the supply circuit is permitted on auxiliary lighting and power equipment.

18.1.3 Flexible cord for connection to the supply circuit is permitted on pendant, high bay, or other luminaires where the intended application is specifically identified as a permitted use of flexible cord in accordance with Subsections 400.10 and 410.62 of the National Electrical Code, NFPA 70-2020.

18.2 Flexible cord

18.2.1 Flexible cord shall be one of the types specified in [Table 18.1](#) and, if grounding is required per [20.1](#), shall be a 3-conductor grounding cord terminating in an attachment plug. The cord for unit equipment shall be no longer than 36 inches (914 mm) measured from the face of the plug to the point at which the cord enters the unit.

Exception: An attachment plug is permitted but not required for pendant and high bay luminaires.

Table 18.1
Cord types

SPT-3 ^a , SP-3 ^a , SPE-3 ^a	SJT	SO
SJ	SJTO	SOO
SJE	SJTOO	ST
SJO	S	STO
SJOO	SE	STOO

^a These cords are for use only with permanently mounted equipment.

18.2.2 The cord shall have an ampacity no less than the current rating of the equipment.

18.3 Alternative connection

18.3.1 If it is intended that the power supply cord can be removed from the unit and permanent connection made to the supply circuit, the compartment in which the connections of the cord are made shall be constructed in accordance with [18.3.2](#) – [18.3.4](#).

18.3.2 The cord shall enter the wiring compartment through a 7/8 inch (22.2 mm) diameter hole that, after the cord and any bushing or fitting provided have been removed, provides an opening for the attachment of the intended wiring system.

18.3.3 The power supply cord shall be connected to the internal wiring by a device such as a terminal block, terminal leads, pressure cable connector, or the like, that will accommodate permanent wiring of the correct size for the unit.

18.3.4 The internal wiring terminals and leads for connection to the power supply shall have identification in accordance with [17.4.1](#), [17.4.2](#), [20.3](#), and [20.9](#).

18.4 Attachment plug

18.4.1 The rating of the attachment plug shall be at least equivalent to the electrical rating of the equipment. If the equipment is adaptable for use at different voltages by field alteration of internal connections, the attachment plug provided shall be rated for the voltage to which the equipment is intended to be connected when shipped from the factory, and the equipment shall be marked per [73A.3.6](#). If required to be of the grounding type per [18.2.1](#), the attachment plug shall be of the 3-blade, grounding type. The attachment plug is permitted to be of the locking type.

18.5 Grounding

18.5.1 The insulation of one of the conductors of the flexible cord shall be green in color with or without one or more yellow stripes. The attachment-plug grounding pin shall be connected to one end of this green grounding conductor, and the unit end of the grounding conductor shall terminate in an effective conductive connection to all accessible, dead-metal parts of the unit.

18.6 Strain relief

18.6.1 Strain relief shall be provided such that a stress on a flexible cord will not be transmitted to terminals, splices, or internal wiring in the unit or in the attachment plug. A knot in the cord is not considered a strain relief means.

18.6.2 A metal strain relief clamp or band without auxiliary protection is acceptable with a power supply cord, unless it is determined that the clamp or band may damage the cord insulation.

18.6.3 The strain relief means shall be tested in accordance with the Strain Relief Test, Section [59](#).

18.7 Push-in prevention

18.7.1 Means shall be provided to prevent the flexible cord from being pushed into the unit through the cord entry hole if such displacement is likely to:

- a) Damage the cord;
- b) Expose it to a temperature in excess of that for which it is rated;

c) Reduce spacings (such as from a live part to a metal strain relief clamp) below the minimum acceptable values; or

d) Damage or interfere with internal components.

18.8 Bushings

18.8.1 At a point where a flexible cord passes through an opening in a wall, barrier, or enclosure, a bushing or the equivalent shall be secured in place, and shall be provided with a smooth, rounded surface against which the cord may bear.

18.8.2 If the cord entry hole is in a material of wood, porcelain, phenolic composition, or other nonconductive material, a smooth, rounded surface is considered to be the equivalent of a bushing.

18.8.3 Ceramic material and some molded compositions are generally effective for insulating bushings, but separate bushings of wood or hot-molded tar and shellac compositions are not.

18.8.4 Vulcanized fiber may be used if the bushing is no less than 0.047 inch (1.19 mm) thick and if it is so formed and secured in place that it will not be adversely affected by conditions of intended use, including exposure to moisture.

18.8.5 A bushing of the same material as the cord and molded integrally with it can be used provided the built-up section is no less than 1/16 inch (1.6 mm) thick at the point where the cord passes through the hole in the enclosure.

18.8.6 An insulated metal grommet may be considered equivalent to an insulating bushing, provided the insulating material is no less than 1/32 inch (0.8 mm) thick and completely fills the space between the grommet and the metal in which it is mounted.

19 Internal Wiring

19.1 Wires

19.1.1 Internal wiring shall consist of general use wire or appliance wiring material rated in accordance with the temperature, voltage, and other conditions of service to which the wiring is likely to be subjected.

19.1.2 With regard to the requirements in [19.1.1](#), some commonly used types of appliance wiring material are as indicated in [Table 19.1](#).

Table 19.1
Appliance wiring material

Types of insulation	Nominal thickness of insulation ^a	
	600-volt applications, inch (mm)	300-volt applications, inch (mm)
Thermoplastic	0.030 (0.76)	0.015 (0.38)
Rubber	0.030 (0.76) plus an impregnated-braid cover	0.015 (0.38) plus an impregnated-braid cover, or 0.030 (0.76) without a braid cover
Neoprene	0.045 (1.14)	0.015 (0.38) plus an impregnated-braid cover, or 0.030 (0.76) without a braid cover

Table 19.1 Continued on Next Page

Table 19.1 Continued

Types of insulation	Nominal thickness of insulation ^a	
	600-volt applications, inch (mm)	300-volt applications, inch (mm)
Silicone rubber	0.030 (0.76) plus an impregnated-braid cover, or 0.030 (0.76) without a braid cover ^b	0.015 (0.38) plus an impregnated-braid cover, or 0.030 (0.76) without a braid cover ^b
^a The minimum thickness is 0.027 inch (0.69 mm) for 0.030 inch (0.76 mm) nominal thick insulation; the minimum thickness is 0.013 inch (0.33 mm) for 0.015 inch (0.038 mm) thick nominal insulation. ^b Only if routed away from live parts of opposite polarity and protected from mechanical damage both during installation of field wiring and while in operation, unless material demonstrates resistance to mechanical damage.		

19.1.3 The thermoplastic or rubber insulation of conductors that are in circuits operating at potentials of 50 volts or less and segregated from all higher voltage wiring shall have no less than 0.015 inch (0.38 mm) nominal thickness.

19.1.4 Leads to an adjustable lamphead shall be of stranded wire and of such length to permit full adjustment of the lamphead without applying stress to the leads or connections. The leads may be flexible cord, such as Type SP-2, SPE-2, or SPT-2, when protected (closely routed to lamp head support), or one of the cord types indicated in [Table 18.1](#), when not closely routed.

19.1.5 Leads connected to parts mounted on a hinged cover shall be of stranded wire and of sufficient length to permit the full opening of the cover without applying stress to the leads or their connections. These leads may be Type SP-2, SPE-2, or SPT-2 cord or appliance wiring material.

19.1.6 Overtinned stranded wire may be used for the purposes described in [19.1.4](#) or [19.1.5](#) when the wire complies with the Overtinned Wire Flexibility Test, Section [61](#). A tin coating shall additionally comply with ASTM B33-91, Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes, and a tin/lead coating shall comply with ASTM B189-90, Standard Specification for Lead-Coated and Lead-Alloy Coated Soft Copper Wire for Electrical Purposes.

19.1.7 A bare conductor, including pigtails and coil leads of automatic, load-control relays, shall be supported so that the spacings required in [37.1.1](#) will be maintained, unless the conductor is covered by insulating sleeving or tubing.

19.1.8 Supplementary insulation, such as coated fabric or extruded thermoplastic insulating tubing, shall be rated for the use and shall not be adversely affected by the temperature to which it may be subjected under any conditions of service.

19.2 Wireways

19.2.1 A wiring space or compartment intended to enclose wires shall be free of any sharp edge, burr, fin, moving part, or the like that may abrade the insulation on conductors or otherwise damage wires.

19.2.2 A hole in a sheet-metal wall 0.042 inch (1.1 mm) thick or less, through which insulated wiring passes, and on the edges of which it may bear, shall be provided with a smoothly rounded bushing. A hole in a wall thicker than 0.042 inch shall have smooth, well-rounded edges.

19.2.3 With respect to the requirement in [19.2.2](#), a bushing of a vulcanized fiber, neoprene, or equivalent material can be used.

19.3 Electrical connections

19.3.1 An electrical connection shall be soldered, welded, or otherwise effectively connected. A soldered joint shall be mechanically secure before soldering.

19.3.2 A lead is considered to be mechanically secure when one or more of the following is provided:

- a) At least one full wrap around a terminal.
- b) At least one right angle bend when passed through an eyelet or opening.
- c) Twisting with other conductors.

19.3.3 A plug and connector may be used with internal wiring if:

- a) The plug and connector are rated for the maximum voltage and temperature involved, and the construction complies with the requirements of this standard with regard to insulating materials, current-carrying parts, and spacings;
- b) The contacts do not attain a maximum temperature in excess of the temperature rating of the insulating material involved;
- c) The connector complies with the test requirements for current rupturing (disconnection under load) in accordance with the Overload Tests in the Standard for Attachment Plugs and Receptacles, UL 498, if the connection is likely to be broken under load; and
- d) No live parts that are a potential risk of electric shock as described in [8.2.1](#), are exposed when the male and female parts are connected or disconnected as determined with the probe described in [19.3.4](#) applied externally to the plug and connector openings.

Exception: The Overload Tests specified in (c) are not required for connectors rupturing a current less than 10 A, if the open circuit potential between any two adjacent pins or any pin and ground is 15 V or less.

19.3.4 The probe mentioned in [19.3.3\(d\)](#) is to be in the form of a cylinder having a radius of 0.205 inch (5.21 mm). The end of the probe which is used to determine the accessibility of live parts is to be rounded into a hemisphere with a radius of 0.205 inch (5.21 mm).

19.3.5 A stranded conductor clamped under a wire-binding screw or similar part shall have the individual strands soldered together or the equivalent to provide an effective connection.

19.3.6 A splice shall be provided with insulation equivalent to that of the wires involved.

19.3.7 An aluminum conductor, insulated or uninsulated, used as internal wiring, such as for interconnection between current-carrying parts or as motor windings, shall be terminated at each end by a method that is effective for the combination of metals involved at the connection point.

19.3.8 If a wire-binding screw construction or a pressure-wire connector is used as a terminating device, it shall be investigated for use with aluminum under the conditions likely to be encountered in service (for example, temperature, heat cycling, or vibration).

19.4 Separation of circuits

19.4.1 Internal wiring of circuits that operate at different potentials shall be separated by barriers or shall be segregated unless the conductors of the circuits of lower voltage are provided with insulation rated for the higher voltage of the combination.

19.4.2 Segregation of insulated conductors may be accomplished by clamping, routing, or equivalent means that provides permanent separation.

19.4.3 A barrier used to separate circuits operating at different potentials shall be secured in place and shall be of metal no less than 0.026 inch (0.66 mm) thick or of an insulation material no less than 0.028 inch (0.71 mm) thick. The barrier shall be of greater thickness if necessary as determined by an investigation.

19.4.4 *Deleted*

19.5 Conductor secureness

19.5.1 Internal wiring that involves a risk of electric shock, fire, or required performance per this standard, and is subject to handling during installation or routine maintenance shall be evaluated for compliance with the Conductor Secureness Test, Section [60](#).

Exception: A component with an integral wiring connection that has already been evaluated for conductor secureness need not be re-evaluated.

19.5.2 An insulating bushing incorporating strain relief shall be sized for the type conductor for which it is intended and shall be mounted in a hole of the size and shape for which it is intended.

20 Grounding

20.1 Equipment with dead metal conductive parts that can become energized and that are accessible to contact during normal operation or routine maintenance or service shall have provisions for connection to the building grounding system.

Exception: Where the dead metal conductive parts that can become energized are accessible only during service, marking the cover to be removed in accordance with [73A.4.9](#) is permitted in lieu of provisions for grounding.

20.2 The following constitute effective means for grounding of equipment:

- a) Equipment intended to be connected only by a metal-enclosed wiring system – a knockout or equivalent opening in the metal enclosure. Such equipment shall be marked in accordance with [73A.3.2](#).
- b) Equipment capable of being connected by a nonmetal-enclosed wiring system (for example, nonmetallic-sheathed cable) – an equipment grounding terminal or lead for each equipment grounding conductor of the system.

20.3 A wire-binding screw intended for the connection of an equipment-grounding conductor shall have a green-colored head that is hexagonal, slotted, or both. A pressure-wire connector intended for connection of such a conductor shall have identification such as by being marked "G," "GR," "GND," "Ground," "Grounding," or the like, or by an equivalent marking on a wiring diagram provided on the equipment.

20.4 An equipment-grounding terminal or lead-grounding point shall be connected to the frame or enclosure by a positive means, such as by a bolted or screwed connection.

20.5 An equipment-grounding connection shall penetrate a nonconductive coating, such as paint or vitreous enamel.

20.6 An equipment-grounding point shall be located so that the grounding means is not likely to be inadvertently removed during servicing.

20.7 An equipment-grounding connection, equipment-grounding conductor, enclosure, frame, component mounting panel, or any other part connected to earth ground shall not carry current except during an electrical malfunction.

Exception No. 1: A low-voltage, limited-energy circuit as described in Determination of Low-Voltage Limited-Energy Circuit Status, Section [50](#), may be connected to a single-point reference ground. Current is not to be carried through the field-equipment-grounding connection, metallic raceway, other grounding means, or an earth ground.

Exception No. 2: A line-bypass, capacitive, impedance circuit for a radio frequency signal circuit or a transient-surge protective device need not comply with this requirement.

Exception No. 3: A transient voltage surge suppressor used to limit transient voltages on power lines need not comply with this requirement.

20.8 A grounded circuit conductor shall not be connected to any equipment-grounding or bonding conductor in a unit.

20.9 The surface of an insulated lead intended for field connection of an equipment grounding conductor shall be green with or without one or more yellow stripes, and no other lead shall have this identification.

20.10 A terminal for connection of an equipment-grounding conductor (input) shall be capable of securing a conductor of a size no less than required in [17.1.1](#).

20.11 A soldering lug, a push-in (screwless) connector, or a quick-connect or similar friction-fit connector shall not be used for the grounding terminal.

Exception: A plug and connector may be used in a grounding or bonding conductor if:

a) The circuit and grounding connections are made by mating one plug and connector; that is, the grounding connection is not to be made through a connector separate from that for the circuit connections; and

b) The grounding connection is made no later and broken no sooner than the circuit connections upon plugging and unplugging of the plug and connector.

20.12 Small, isolated (insulated) dead-metal parts are not required to be grounded.

20.13 A secondary circuit shall be isolated from ground unless it can be shown that neither a risk of fire nor electric shock will result if that circuit is grounded.

21 Bonding of Internal Parts

21.1 In a unit having provisions for grounding, all uninsulated metal parts of the enclosure, component mounting brackets, capacitors, and other electrical components likely to become energized and that involve a risk of electric shock shall be bonded for grounding if they can be contacted by persons or inadvertently contacted by service personnel.

Exception: A metal part as described in (a) – (f) need not be bonded for grounding:

- a) *An adhesive-attached metal foil marking, a screw, a handle, or the like, that is located on the outside of an enclosure or cabinet and isolated from electrical components or wiring by grounded metal parts so that they are not likely to become energized.*
- b) *An isolated metal part, such as a small assembly screw, that is positively separated from wiring and uninsulated live parts.*
- c) *A panel or cover that does not enclose uninsulated live parts if wiring is positively separated from the panel or cover so that it is not likely to become energized.*
- d) *A panel or cover that is insulated from electrical components and wiring by an insulating barrier of vulcanized fiber, varnished cloth, phenolic composition, or similar material no less than 1/32 inch (0.8 mm) thick and secured in place. A barrier or liner of other materials or a lesser thickness than specified may be used if it complies with the requirements for internal barriers in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.*
- e) *An isolated metal part that is mounted on a printed-wiring board – such as a transformer core or a heat sink – and not exposed to contact during routine operation or maintenance.*
- f) *A capacitor sleeved with insulating tubing that complies with [37.3.1](#).*

21.2 When the effectiveness of any portion of a required bonding system is uncertain, the complete unit shall be subjected to the Grounding Continuity Test, Section [63](#).

21.3 Regarding [21.1](#), dead-metal parts that are likely to become energized are normally non-current-carrying, metallic parts separated from any current-carrying parts by less than two layers of insulation. Solid insulation rated for the voltage involved (such as insulated wiring) represents a single layer of insulation. A reliably maintained air gap in accordance with the required spacing for the voltage involved also represents a single layer of insulation. Except for air, multiple layers of insulation relied upon to isolate dead-metal parts from current-carrying parts shall be constructed of dissimilar materials.

21.4 If the continuity of the grounding system relies on the dimensional integrity of a non-metallic material, the material shall be acceptable for the purpose when investigated for creep in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

21.5 A separate component bonding conductor shall be of copper, a copper alloy, or other material acceptable for use as an electrical conductor. Ferrous metal parts in the grounding path shall be protected against corrosion by painting, galvanizing, plating, or equivalent means. A separate bonding conductor or strap shall:

- a) Be protected from mechanical damage or be located within the outer enclosure or frame;
- b) Not be secured by a removable fastener used for any purpose other than bonding for grounding, unless the bonding conductor is unlikely to be omitted after removal and replacement of the fastener; and
- c) Not be spliced.

21.6 The bonding shall be by a positive means, such as by clamps, rivets, bolted or screwed connections, or by welding, soldering, or brazing with materials having a softening or melting point greater than 455°C (851°F). The bonding connection shall penetrate nonconductive coatings, such as paint or vitreous enamel.

21.7 A separate component-bonding conductor, including a printed-wiring board trace, shall either:

- a) Not be smaller than the size specified in [Table 21.1](#);

- b) Not be smaller than the conductor supplying the component; or
- c) Comply with the requirements in the Bonding Conductor Test, Section [62](#).

Exception: The bonding conductor size for exit fixtures, emergency lighting fixtures, remote lamp assemblies, exit lights, and unit equipment electric discharge lighting fixtures with integral component power supplies shall comply with the requirements for lighting fixtures.

Table 21.1
Size of equipment grounding and bonding conductor

Maximum current rating, ^a amperes	Minimum size of equipment grounding or bonding conductor			
	Copper,		Aluminum or copper-clad aluminum,	
	AWG or kcmil	(mm ²) ^b	AWG or kcmil	(mm ²) ^b
20	12	(3.3)	10	(5.3)
60	10	(5.3)	8	(8.4)
90	8	(8.4)	6	(13.3)
100	8	(8.4)	6	(13.3)
150	6	(13.3)	4	(21.2)
200	6	(13.3)	4	(21.2)
300	4	(21.2)	2	(33.6)
400	3	(26.7)	1	(42.4)
500	2	(33.6)	1/0	(53.5)

^a Maximum ampere rating of the input circuit overcurrent protective device in [66.2.3](#) or the output circuit overcurrent protective device described in [26.1](#) – [26.2](#).

^b The equipment grounding conductor in the cord for cord-connected unit equipment may be the same size as the current-carrying conductors.

22 Batteries

22.1 Batteries that serve as an emergency power source shall be rechargeable and shall comply with this Section.

22.2 Batteries that are replaceable shall include a protective housing (casing) that allows them to be handled without risk of damage to the cells contained within.

22.2.1 Secondary cells and batteries shall comply with the applicable requirements of one (or more) of the following standards:

- a) UL 1642, Lithium Batteries
- b) UL 2504, Household and Commercial Batteries
- c) UL 62133-1, Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, and for Batteries Made from Them, for Use in Portable Applications – Part 1: Nickel Systems
- d) UL 62133-2, Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, and for Batteries Made from Them, for Use in Portable Applications – Part 2: Lithium Systems.
- e) UL 1973, Batteries for Use in Stationary and Motive Auxiliary Power Applications



f) UL 1989, Standby Batteries

22.2.1.1 Deleted

22.2.1.2 Deleted

22.2.2 Batteries shall be located and mounted in a manner that, during replacement or use, prevents misalignment, reverse polarity, damage to connections, loose connections, or access to uninsulated parts that represent a risk of electric.

22.2.3 The charging circuitry for lithium batteries shall comply with the Lithium Battery Charge Rate Measurement Test, Section [48A](#), and the Lithium Battery Charging Circuit Abnormal Test, Section [48B](#).

22.3 Unless marked or specified otherwise by the manufacturer, the rated battery voltage is to be calculated on the following basis:

Battery type	Volts per cell
Lead acid	2.0
Nickel cadmium	1.2
Nickel metal Hydride	1.2
Lithium nickel manganese cobalt oxide (NMC)	3.7
Lithium iron phosphate (LFP)	3.3

22.4 A battery shall be located and mounted so that the terminals of cells will be prevented from coming into contact with terminals of adjacent cells or with metal parts of the battery compartment as the result of shifting of the battery. Cells in jars of conductive material shall be installed in trays of nonconductive material.

22.5 A battery whose maintenance requires the addition of water, electrolyte, or other liquids shall have transparent or translucent jars.

22.6 A sealed battery/cell with a pressure release device shall comply with the Pressure Release Test requirements specified in the Standard for Standby Batteries, UL 1989.

22.7 A vented battery with flame arrestor vent caps shall comply with the Flame Arrestor Vent Cap Test requirements specified in the Standard for Standby Batteries, UL 1989.

Exception: The Back Pressure Test specified in UL 1989 need not be conducted.

22.8 Battery packs consisting of more than one battery or cell shall not permit individual batteries or cells to be replaced, in order to avoid mixing new and old batteries that can create voltage imbalances within the cells.

22.9 Equipment with batteries connected in a manner capable of producing 60 Vdc or greater shall be provided with Backfeed Protection in accordance with Annex FF (normative) and Annex GG (informative) of the fourth edition of the Standard for Uninterruptible Power Systems, UL 1778.

22.10 Central station and unit equipment is permitted to be shipped without the batteries it has been evaluated for use with when marked per [73A.4.11](#) and provided with instructions per [74.6](#).

22.11 Equipment with batteries shall be marked with battery replacement information per [73A.4.11](#).

23 Electronic Circuits

23.1 Electronic components and circuits relied upon to reduce the risk of fire or electric shock shall be evaluated for performance reliability in accordance with the applicable component standard. Where compliance with such standards has not been established, the equipment shall be subject to the Component Breakdown Test program of Section [66](#).

23.2 Equipment containing solid-state components conductively connected to a branch circuit shall be subject to the Voltage Surge Test, Section [55](#).

23.3 Electronic circuits that activate emergency lighting in response to an external signal (loss of normal power, fire alarm, motion sensor or the like) shall be subject to the ELCF Test, Section [47](#), and shall operate in accordance with [47.2](#) or issue a derangement signal appropriate for the condition in accordance with [47.7](#).

24 Capacitors

24.1 A capacitor shall use such materials and shall be constructed so that it will not constitute a risk of fire. It shall not be damaged by the temperatures to which it may be subjected under the more severe conditions of intended use. A paper capacitor shall be impregnated or enclosed to exclude moisture. An electrolytic or other special type of capacitor, or a capacitor intended for connection directly across the line, shall be investigated in all respects for the particular application.

25 Lampholders

25.1 The potential on an integral screw shell lampholder of the medium base type or smaller shall not exceed 150 volts open circuit, either to ground or between conductors, as measured at the terminals of the lampholder.

26 Overcurrent (Overload) Protection

26.1 Equipment with batteries of capacity greater than 20 ampere-hours with provision for the connection of remote lighting or power equipment shall have integral overcurrent protection for the output circuit, or shall be marked to identify the overcurrent protection to be provided by others.

26.2 The overcurrent protection specified in [26.1](#) may include fuses, circuit breakers, supplementary protectors, or circuit impedance as determined appropriate for the application. The overcurrent device amperage rating shall be no less than 125% of the load rating for the connected remote equipment, to limit the risk of nuisance tripping.

26.3 If a circuit breaker is operated vertically rather than rotationally or horizontally, the up position of the handle shall be the on position.

26.4 A fuseholder in equipment rated and marked for an rms symmetrical short-circuit current rating of more than 10,000 amperes shall have provision for accommodating a Class CC, G, J, L, RK-1, RK-5, or T fuse. The fuseholder shall not accommodate a Class H or K fuse nor a miscellaneous or miniature fuse.

Exception: A fuseholder on the secondary side of a control transformer may accommodate a Class H or K fuse, Type S fuse, Edison-base plug type fuse, or a miscellaneous or miniature fuse.

26.5 A fuseholder used in series with a circuit breaker in equipment having a marked short-circuit current rating higher than the interrupting capacity rating of the circuit breaker shall have provision for accommodating a Class CC, G, J, L, RK-1, RK-5, or T fuse. The fuseholder shall not accommodate a Class H or K fuse nor a miscellaneous or miniature fuse.

27 Coil Windings

27.1 The insulation of coil windings in relays, transformers, and the like shall be such as to resist the absorption of moisture.

27.2 Film-coated wire does not require additional treatment to prevent moisture absorption.

28 Derangement Signals

28.1 Equipment incorporating batteries and battery-charging means shall provide audible or illuminated visible indicator(s) that change status and are detectable to facility maintenance personnel without the need to adjust or remove any equipment covers or parts. The indicators are permitted to be located directly on the equipment itself, or may be remotely located and triggered to activate by a wired or wireless control signal issued by the equipment.

28.2 Derangement signal activation shall occur under each of the following conditions, if applicable to the equipment under test:

a) Disconnection of the battery power source;

Exception: Disconnection of the battery need not be considered for equipment with batteries not intended for replacement, maintenance or service, such as an emergency battery pack or equipment marked in accordance with [73A.4.8](#).

b) The battery is actively supplying a remote (but not concurrently a local) load while normal power remains available;

c) The battery charger is not receiving its intended charging voltage or has experienced an internal failure that inhibits its ability to provide the intended charging current to the battery; or

d) For self-testing / self-diagnostic equipment, detection of a non-functional feature during a self-testing/self-diagnostic routine, in accordance with [30.1](#).

e) *Deleted*

28.3 Compliance with [28.2](#) shall be determined through testing per the Emergency Lighting Control Functionality (ELCF) Test, Section [47](#). Compliance with Section [47](#) does not require a prescribed level of brightness or sound for any required indicator. The type of indicator response need only be appropriate for the indicator's location (i.e., sufficiently bright or loud if intended to be detected in a large space, versus a text or graphical message if sent to a remote display or handheld device).

28.4 When tested per the Emergency Lighting Control Functionality (ELCF) Test, Section [47](#), derangement signal activation is not required to occur immediately or automatically upon initiation of the applicable conditions from [28.2](#). A derangement signal that activates when the test switch (see [29.1](#)) is operated subsequent to imposing the condition from [28.2](#) is also considered compliant with this requirement.

29 Test Switch

29.1 Equipment provided with an ELCF shall have means for periodic testing, such as an integral or remote (wired or wireless) switch, to simulate the conditions under which the ELCF is intended to operate (such as loss of the normal supply). The test switch shall be evaluated per Emergency Lighting Control Functionality (ELCF), Section [47](#).

Exception: Equipment that has self-test/self-diagnostic capabilities in accordance with Self-Testing/Self-Diagnostic Equipment, Section [30](#), need not be provided with a manually operable test switch.

29.2 A test switch of the maintained-break type shall be accessible only to service personnel. A maintained-break type switch shall open all ungrounded conductors.

29.3 A test switch of the momentary-break type, that returns the equipment to normal status when released, shall be accessible to maintenance personnel (see [4.49](#), routine maintenance) without the need for tools to remove a panel or barrier.

29A Emergency Lighting Control Devices

29A.1 An ELCD that has control functionality (“on”, “off”, “dim”, etc.) subject to testing under [47.2\(c\)](#) shall have means to monitor the input signal referred to in [47.2\(c\)](#) for the branch circuit associated with its controlled loads. This input signal monitoring feature, which can be wired or wireless, shall be continuously functional and independent of the emergency power feeding through the ELCD to the load

29A.2 An ELCD that has functionality related to facility conditions beyond the status of normal power availability requires evaluation as part of the system it is designed to work within, for that facility and as approved by an authority having jurisdiction. Such additional functionalities, which may consider real-time conditions and hazards, and that may involve software algorithms to make real-time facility infrastructure adjustments, are beyond the scope of this Standard.

30 Self-Testing/Self-Diagnostic Equipment

30.1 Equipment that contains self-testing/self-diagnostic capability shall automatically perform a minimum 30 second test at least once every 30 days to verify the following:

- a) ELCF operation;
- b) Battery charger system functionality;
- c) Battery terminal voltage no less than 87.5 percent of nominal; and
- d) Availability and functionality of connected loads. Based on preset or recalibrated levels indicating load availability, a derangement signal shall occur when the levels deviate by more than 50 percent for exit signs, more than 25 percent for unit equipment and emergency battery packs, and more than 10 percent for central station battery systems. The means to determine the availability of connected loads shall be appropriate for the equipment technology, such as a measurement of impedance (for incandescent loads) or drive current (for LED loads).

NOTE: The load percentages reflect a number of discrete load devices typically associated with each equipment type – two lamps or light sources within an exit sign, 2 integral plus 2 remote lamps for unit equipment and emergency battery packs, and multiple separate loads for central station battery systems. Where the equipment under test has fewer discrete light sources, the percentage of load loss for detection purposes can be adjusted accordingly. For example, unit equipment with two lamps but no means for connection of remote lamps would be required to detect only a 50% loss of load rather than a 25% loss.

The equipment shall be tested in accordance with [47.7](#) and [47.8](#), and be provided with user instruction manual content per [74.4](#).

30.1.1 Equipment with a range of output levels and subject to loads being added or removed after initial installation shall be marked in accordance with [73A.4.13](#).

30.2 A self-testing function that discharges more than 30 minutes of the total capacity of a system battery that supplies more than one lighting unit shall have provision, such as a programmable or random delay

generator, to reduce the risk that the battery will be excessively discharged as a result of simultaneous or consecutive self-tests.

30.3 Equipment that is self-diagnostic only shall be marked in accordance with [73A.4.14](#).

30.4 Equipment that allows self-testing/self-diagnostic capability to be disengaged shall allow access to the disengagement means only to service personnel.

31 Disconnect Switches and Fuses

31.1 Equipment with batteries and having provision for connection of remote equipment shall have means (switches, fuses, wiring device connectors, or similar) to disconnect all remote equipment from both the normal and emergency supply sources. The disconnecting means shall be accessible only to service personnel and shall open all conductors that represent a risk of fire or electric shock.

31.2 If a disconnect switch handle is operated vertically rather than rotationally or horizontally, the up position of the handle shall be the "ON" position.

31.3 Equipment shall be provided with means, accessible only to service personnel, to disable the battery circuit of an emergency battery pack during installation and servicing of the equipment.

32 Transformers

32.1 A transformer relied upon to reduce the risk of electric shock shall be of the isolating type; that is, one having no connections common to both primary and secondary windings.

Exception: This requirement does not apply to a sealed unit that is marked as specified in [73A.4.8](#).

32.2 Transformers shall comply with Supplement [SD](#), Alternative Requirements for Transformers.

33 Impedance Networks

33.1 Battery-charging circuits provided by an impedance network shall provide the same level of output under reverse polarity input, unless means that are not easily defeated are provided to prevent reverse polarity input. Where needed, compliance is verified using the method of Section [48A](#).

34 Printed-Wiring Board

34.1 A printed-wiring board or printed-wiring assembly provided as part of equipment shall be investigated for the particular application.

34.2 A resistor, capacitor, inductor, transformer, transistor, diode, or other component or part that is mounted on a printed-wiring board, to form a printed-wiring assembly, shall be securely mounted.

34.3 Consideration is to be given to the mechanical protection and electrical insulation afforded to the component or part by a barrier or partition.

35 Motors

35.1 A motor provided as part of equipment shall be investigated for the particular application and shall be capable of intended operation, without introducing a risk of fire, electric shock, or injury to persons.

35.2 A motor winding shall resist the absorption of moisture.

36 Equipment Using Simple Reactance Ballasts and Lamps Having Integral Starters

36.1 Exit lights, exit fixtures, or other emergency lighting equipment intended for use with simple reactance ballasts and lamps having integral starters shall comply with the requirements specified in the Temperature Test, Section 52, when tested with the intended lamp types and wattages indicated in the lamp replacement marking.

37 Spacings

37.1 General

37.1.1 Where a risk of fire or electric shock exists, minimum spacings shall be in accordance with [Table 37.1](#) or [Table 37.2](#), as applicable.

Exception No. 1: The spacings given in [Table 37.1](#) do not apply:

- a) Within snap switches, lampholders, and similar wiring devices;*
- b) Between uninsulated live parts of a wiring device and dead-metal that is part of the wiring device (including mounting screws, rivets, yoke, clamp, and the like); or*
- c) Between such live parts and that part of a dead-metal surface on which the device is mounted in the intended manner.*

Exception No. 2: Other than at field wiring terminals or to the enclosure, clearances and creepage distances between parts that are rigidly held in place are permitted to be in accordance with the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840. Environmental conditions shall be assumed to be pollution degree 3 unless specific measures are included in the equipment to provide for less severe conditions.

Table 37.1
Spacings

Spacing involved between uninsulated live parts and:		Minimum spacing							
		0 – 50 volts rms, ^a		51 – 150 volts rms, ^a		151 – 300 volts rms, ^a		301 – 600 volts rms, ^a	
		inch	(mm)	inch	(mm)	inch	(mm)	inch	(mm)
Uninsulated live parts of opposite polarity	Through air	1/16 ^b	(1.6)	1/8 ^c	(3.2)	1/4	(6.4)	3/8	(9.5)
	Over surface	1/16 ^b	(1.6)	1/4	(6.4)	3/8	(9.5)	1/2	(12.7)
Uninsulated grounded dead-metal parts other than the enclosure, or exposed dead-metal parts that are isolated	Through air	1/16 ^b	(1.6)	1/8 ^c	(3.2)	1/4	(6.4)	3/8	(9.5)
	Over surface	1/16 ^b	(1.6)	1/4	(6.4)	3/8	(9.5)	1/2	(12.7)
Wall of metal enclosure, including fittings for conduit or armored cable ^d	Through air	1/4	(6.4)	1/2	(12.7)	1/2	(12.7)	1/2	(12.7)
	Over surface	1/4	(6.4)	1/2	(12.7)	1/2	(12.7)	1/2	(12.7)

^a For peak voltages and battery voltages, multiply applicable rms voltage by $\sqrt{2}$.

^b The spacing between installation-wiring terminals of opposite polarity and between a wiring terminal and a grounded, dead-metal part shall be no less than 1/8 inch (3.2 mm) through air and 1/4 inch (6.4 mm) over surface.

^c The spacing between installation-wiring terminals of opposite polarity and between a wiring terminal and a grounded, dead-metal part shall be no less than 1/4 inch (6.4 mm).

^d A metal piece attached to a metal enclosure is considered to be a part of the enclosure if deformation of the enclosure is likely to reduce spacings.