



UL 2442

STANDARD FOR SAFETY

Wall- and Ceiling-Mounts and Accessories

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UL Standard for Safety for Wall- and Ceiling-Mounts and Accessories, UL 2442

First Edition, Dated March 16, 2011

Summary of Topics

This revision to ANSI/UL 2442 is being issued to incorporate the following:

Addition of Requirements to Address Entrapment Hazards with Ceiling-Mounted Products

Addition of Requirements to Address Mounts Provided with Permanent Electrical Connections

Addition of Requirements to Address Outdoor-Use Mounting Systems

Correction to the Title of Section 31

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

These new requirements are substantially in accordance with Proposal(s) on this subject dated September 7, 2012.

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

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Future Effective Date	Reference
April 7, 2014	Entire Standard



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1

UL 2442

Standard for Wall- and Ceiling-Mounts and Accessories

First Edition

March 16, 2011

This ANSI/UL Standard for Safety consists of the First Edition including revisions through November 16, 2012.

The most recent designation of ANSI/UL 2442 as an American National Standard (ANSI) occurred on November 16, 2012. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, or effective date information.

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PART 1 – ALL MOUNTING SYSTEMS

INTRODUCTION

1 Scope

1.1 These requirements apply to shelves, brackets, and similar devices, that provide structural support for the mounting of audio/video equipment, information technology equipment, and similar products, to the building structure and are intended for indoor use only.

1.1 effective April 7, 2014

1.2 These requirements also apply to accessories that are used to expand the capability of a mounting device; accessories that are used to secure the mounting device to a wall, ceiling, suspended ceiling, truss, joist, "I" beam, or other building structural component specified by the manufacturer; and any accessories used to secure an apparatus to the mount. Examples of such products include extension columns, extension arms, ceiling plates, floor plates, ceiling brackets, fastener kits, and VCR/DVD brackets.

1.2 effective April 7, 2014

1.3 A furnishing intended to support audio equipment or a video display (such as CRT, LCD, and Plasma) shall be evaluated in accordance with one of the following:

- a) A furnishing which is floor supported and intended to support a video display but is not intended for use as a mobile cart for the video display shall be evaluated to the Standard for Household and Commercial Furnishings, UL 962, and may include features that allow securement to the building structure;
- b) If the furnishing is provided with casters or wheels, the Standard for Household, Commercial, and Professional-Use Carts and Stands for Use with Audio/Video Equipment, UL 1678, or the Standard for Tall Institutional Carts for Use With Audio-, Video-, and Television-Type Equipment, UL 1667, as applicable to the use of the cart shall apply;
- c) If the furnishing is intended to be mounted to walls, ceilings or another permanent part of a building as the primary support means, this Standard shall apply;
- d) If a furnishing is supplied with all of the video and/or audio components by the manufacturer of those components, the requirements contained in the video or audio component standard shall be applied – the Standard for Audio, Video and Similar Electronic Apparatus, UL 60065, or the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, – as applicable to the product.

Exception: A video display support system evaluated in accordance with (a) – (c) above and supplied with all of the video and/or audio components is not subject to (d).

1.3 effective April 7, 2014

1.4 These requirements do not apply to the following products:

- a) Carts and stands. The Standard for Household, Commercial and Professional-Use Carts and Stands for Use with Audio/Video Equipment, UL 1678, and the Standard for Tall Institutional Carts for Use With Audio-, Video-, and Television-Type Equipment, UL 1667, apply to these products.

b) The following products covered by the Standard for Household and Commercial Furnishings, UL 962:

- 1) Motor-operated furniture, such as motor-operated beds and chairs;
- 2) Electrified and non-electrified furniture, such as:
 - i) Lighted curio cabinets;
 - ii) Microwave carts; and
 - iii) Bed headboards.
- 3) Non-seasonal electrical decorations such as lava lamps and wave machines;
- 4) Home and individual office furnishings, such as study carrels, consoles and desks;
- 5) Commercial product and informational displays such as:
 - i) Shelving units;
 - ii) Kiosks (such as the mini-stores in the middle of a mall);
 - iii) Cash station stands;
 - iv) Motorized carpet displays; and
 - v) Product platforms.
- 6) Electrified building components, such as windows and built in bathroom cabinets; and
- 7) Other similar miscellaneous furnishings intended for use in residential or commercial environments.

1.4 effective April 7, 2014

1.5 These requirements do not apply to a mounting device provided with a specific product when the specific product standard is provided with requirements to address the mounting device. Such combinations shall comply with the applicable requirements of the end-use product standard.

1.5 effective April 7, 2014

1.6 These requirements do not cover products intended for use in patient care areas including where oxygen is being used. Patient care products are covered by the Standard for Medical Electrical Equipment, Part 1: General Requirements for Safety, UL 60601-1.

1.6 effective April 7, 2014

1.7 These requirements do not cover products that are specifically intended for infants or juveniles.

1.7 effective April 7, 2014

1.8 These requirements do not cover the mount to supported apparatus interface.

1.8 effective April 7, 2014

2 Glossary

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

2.1 effective April 7, 2014

2.2 APPARATUS – Video display, computer, amplifier, speaker and similar components intended to be supported by the mounting system.

2.2 effective April 7, 2014

2.3 ATTENDED EQUIPMENT – Equipment intended for use where operator presence is required for the equipment to function but is not necessarily required for the equipment to operate.

2.3 effective April 7, 2014

2.4 BALLAST – A current limiting device required to start and operate fluorescent and cold cathode lamps.

2.4 effective April 7, 2014

2.5 BULB (LAMP) – A device which emits light.

2.5 effective April 7, 2014

2.6 CLASS 2 CIRCUIT – An isolated secondary circuit involving a potential of not more than 30-volt rms maximum 42.4 volts peak open circuit secondary potential under any condition of loading or open circuit. There shall be no electrical connection between the primary and secondary windings of a transformer or between a primary or secondary circuit and the enclosure.

a) An inherently-limited Class 2 transformer;

b) A combination of an isolated transformer secondary winding and a fixed impedance or regulating network that together comply with the performance requirements for an inherently limited Class 2 transformer; or

c) One or more combinations of a transformer and an overcurrent protective device that together comply with the performance requirements for a noninherently-limited Class 2 transformer.

2.6 effective April 7, 2014

2.7 CLEARANCE DISTANCE – The shortest distance measured through air between conductive parts.

2.7 effective April 7, 2014

2.8 DECORATIVE PART – A part of the mounting system that has no safety function.

2.8 effective April 7, 2014

2.9 DEDICATED STORAGE AREA – An integral part of a mounting system intended to accommodate specific accessories such as media tapes and discs.

2.9 effective April 7, 2014

2.10 DETACHABLE POWER-SUPPLY CORD – A flexible cord, for supply purposes, able to be connected to or disconnected from the mounting system by means of a suitable mounting system coupler.

2.10 effective April 7, 2014

2.11 NON-DETACHABLE POWER-SUPPLY CORD – A flexible cord, for supply purposes, fixed to or assembled with the mounting system.

2.11 effective April 7, 2014

2.12 ENCLOSURE, ELECTRICAL – That part of the mounting system that:

a) Renders inaccessible all or any parts of the equipment that may otherwise present a risk of electric shock; and/or

b) Retards propagation of flame initiated by electrical disturbances occurring within.

2.12 effective April 7, 2014

2.13 ENCLOSURE, MECHANICAL – A part of the mounting system intended to reduce the risk of injury due to mechanical and other physical hazards.

2.13 effective April 7, 2014

2.14 EXPOSED PART – A part that is not enclosed to prevent contact.

2.14 effective April 7, 2014

2.15 FLAMMABILITY CLASSIFICATION – The flammability classification of a material is determined by tests described in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, or for surfaces greater than 10 square feet, the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723.

2.15 effective April 7, 2014

2.16 FRICTION MATERIAL – Rubber or elastomer with or without dimples or ridges. Plastic or metal with or without dimples or ridges is not a friction material.

2.16 effective April 7, 2014

2.17 GLAZING – To furnish or fit with glass or a clear polymer.

2.17 effective April 7, 2014

2.18 GUARD – That portion of the mounting system that reduces the risk of electric shock or injury to persons.

2.18 effective April 7, 2014

2.19 HAZARDOUS SUBSTANCES AND ARTICLES – As defined by the United States Code of Federal Regulations 16 CFR PART 1500 to 1512.

2.19 effective April 7, 2014

2.20 INSTALLER ASSEMBLY – Any mechanical assembly and installation of a mounting system performed by a trained installer.

2.20 effective April 7, 2014

2.21 INSULATION

- a) INSULATION SYSTEM – An assembly of insulating materials used to isolate the live parts from ground and from parts of opposite polarity. All materials in contact with the windings are considered part of the system.
- b) BASIC INSULATION – Insulation to provide basic protection against electric shock.
- c) SUPPLEMENTARY INSULATION – Independent insulation applied in addition to BASIC INSULATION in order to reduce the risk of electric shock in the event of a failure of the BASIC INSULATION.
- d) DOUBLE INSULATION – Insulation comprising both BASIC INSULATION and SUPPLEMENTARY INSULATION.
- e) REINFORCED INSULATION – A single insulation system which provides a degree of protection against electric shock equivalent to DOUBLE INSULATION under the conditions specified in this standard.

2.21 effective April 7, 2014

2.22 INTERLOCK – A switch or other device that de-energizes the load when an enclosure or guard is opened, displaced, or the mount is serviced.

2.22 effective April 7, 2014

2.23 INTERMITTENT DUTY MOTOR – A motor intended to be connected to a load other than a fan or blower and that is intended to operate for a specified time period.

2.23 effective April 7, 2014

2.24 INTERMITTENT OPERATION EQUIPMENT – Operation in a series of specified cycles each composed of a period of operation under NORMAL LOAD, followed by a rest period with the equipment switched off or running idle.

2.24 effective April 7, 2014

2.25 ISOLATED SECONDARY CIRCUIT – A circuit derived from an isolated secondary winding of a transformer and that has no direct connection back to the line-connected circuit (other than through grounding means). A secondary circuit that has a direct connection back to the line-connected circuit is part of the line-connected circuit.

2.25 effective April 7, 2014

2.26 LIMITED POWER SOURCE (LPS) – A limited power source is as defined in the Standard for Information Technology Equipment Safety – Part 1: General Requirements, UL 60950-1, and that complies with the requirements of UL 60950-1.

2.26 effective April 7, 2014

2.27 LIVE PART – A conductive part that has a potential difference during operation with respect to ground or any other conductive part.

2.27 effective April 7, 2014

2.28 LOCKED-ROTOR CURRENT – The current measured from the line when the armature or rotor is prevented from rotating.

2.28 effective April 7, 2014

2.29 LOW-VOLTAGE CIRCUIT – A circuit involving a potential of not more than 30 volts alternating current (42.4 peak) open circuit.

2.29 effective April 7, 2014

2.30 MOTOR-OPERATED MOUNTING SYSTEM – A mounting system provided with a motor for movement of some portion of the mounting system.

2.30 effective April 7, 2014

2.31 MOUNTING SYSTEM TYPES

a) STATIC MOUNT – A mounting device designed as a single component or constructed of nonadjustable components intended to support an apparatus in a fixed position.

b) ADJUSTABLE MOUNT – A mounting system designed with components that may be adjusted once (or infrequently) and intended to support the apparatus in a fixed position after assembly and installation. All joints and connections of an adjustable mount shall be rigid when assembled according to the installation and assembly instructions.

c) ARTICULATING MOUNT – A mounting system intended to allow active movement, adjustment, and/or repositioning, after installation.

d) MOTOR OPERATED ARTICULATING MOUNT – A motor-operated mounting system intended to allow frequent movement, adjustment, and/or repositioning, after installation.

2.31 effective April 7, 2014

2.32 MOUNTING BRACKET – The interface that attaches the apparatus to a mounting system.

2.32 effective April 7, 2014

2.33 MOUNTING SURFACE – The building structure intended to fasten to or support the mounting device.

2.33 effective April 7, 2014

2.34 MOUNTING SYSTEM – A device that allows an apparatus to be attached to a building structure.

2.34 effective April 7, 2014

2.35 NORMAL MAINTENANCE AND USE – The cleaning, adjusting, moving, maintaining, and using of the mounts. Includes items such as:

a) Replacing a lamp, starter or fuse;

b) Adjustment of a movable, removable or flexible part; and

c) Removal or cleaning of all parts not secured by use of tools.

2.35 effective April 7, 2014

2.36 OPEN MOTOR – A motor having ventilating openings that provide for the passage of external cooling air over and around the windings.

2.36 effective April 7, 2014

2.37 ORDINARY TOOLS – Tools which are normally expected to be available to the user for installing the mounting system, such as flat-bladed and cross-recessed head (Phillips-type) screwdrivers, hammers, nut drivers, wrenches, pliers, electric drills, and similar tools, or those provided with the product.

2.37 effective April 7, 2014

2.38 POLYMERIC MATERIAL – Thermoplastic, thermosetting, and elastomeric materials.

2.38 effective April 7, 2014

2.39 PRINTED-WIRING BOARD (PWB) – The finished combination of a pattern of conductive paths either on or within multilayer sheets of insulating material.

2.39 effective April 7, 2014

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

2.40 effective April 7, 2014

2.41 SAFETY CIRCUIT – A circuit involved with sensing the presence of a user or bystander which is in danger of risk of injury from the mounting system and places or stops the mounting system in a position that prevents a risk of injury to a user or bystander under normal and abnormal circuit operation.

2.41 effective April 7, 2014

2.42 SAFETY INTERLOCK – A means either of preventing access to a hazardous area until the hazard is removed, or of automatically removing the hazardous condition when access is gained.

2.42 effective April 7, 2014

2.43 SECONDARY CIRCUIT – A circuit that is supplied by an induced voltage from a primary where a primary circuit is that supplied by a branch circuit.

2.43 effective April 7, 2014

2.44 SUPPORTING SURFACE – Any surface (shelf, platform, mounting bracket or similar surface) that is intended to support products such as audio/video equipment, information technology equipment, and video and audio discs and tapes.

2.44 effective April 7, 2014

2.45 THERMAL-DEVICE-PROTECTED MOTOR – A motor that relies upon a device (protector) to prevent overheating.

2.45 effective April 7, 2014

2.46 THERMAL PROTECTOR – A device installed integrally within a motor that is responsive to motor current and temperature or temperature only and that, when applied as intended, prevents overheating. Types are: thermal cutoff, automatically reset, manually reset and single-operation.

2.46 effective April 7, 2014

2.47 TOTALLY-ENCLOSED MOTOR – A motor that is enclosed to prevent the free exchange of air between the inside and outside of the winding enclosure and not so enclosed as to be airtight.

2.47 effective April 7, 2014

2.48 USER ADJUSTABLE FASTENER – A fastener or pivot of an Adjustable Mount intended to be loosened or tightened to allow adjustment or to provide tension adjustment for an Articulating Mount.

2.48 effective April 7, 2014

2.49 USER ASSEMBLY – Any mechanical assembly and installation of a mounting system performed by the user.

2.49 effective April 7, 2014

2.50 USER SERVICING – See Normal Maintenance and Use, 2.35.

2.50 effective April 7, 2014

3 Components

3.1 Except as indicated in 3.2, a component of a product covered by this standard shall comply with the requirements for that component.

3.1 effective April 7, 2014

3.2 A component is not required to comply with a specific requirement that:

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

3.2 effective April 7, 2014

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

3.3 effective April 7, 2014

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

3.4 effective April 7, 2014

4 Units of Measurement

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

4.1 effective April 7, 2014

5 Undated References

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

5.1 effective April 7, 2014

CONSTRUCTION

GENERAL

6 General

6.1 A mounting device shall be constructed so that:

- a) User assembly and normal use do not result in a risk of fire, electric shock, or injury to persons; and
- b) The materials and components are used within their mechanical, electrical, and temperature limits.

6.1 effective April 7, 2014

7 Accessories

7.1 A mounting device having provisions for the use of a mechanical or electrical accessory intended to be attached in the field shall comply with the requirements in this standard, with or without the accessory installed.

7.1 effective April 7, 2014

7.2 Installation of an electrical accessory by the user shall be by means of keyed mating electrical connectors.

7.2 effective April 7, 2014

7.3 When an accessory is to be installed by the user, the mounting device shall comply with this Standard before and after the installation of the accessory.

7.3 effective April 7, 2014

7.4 The installation of electrical connectors of an installer-assembled accessory shall be by means of receptacles, plug-in connectors, insulated wire connectors, or by connection to existing wiring terminals.

7.4 effective April 7, 2014

7.5 With reference to 7.4, an installation shall not require the cutting of wiring or the soldering of connections by the installer. Installations shall not require cutting, drilling, or welding in electrical enclosures and in other areas where such operations may damage electrical components and wiring within the enclosure.

7.5 effective April 7, 2014

7.6 A means for strain relief of wires and cords shall be provided and comply with the Strain Relief Test, Section 57, and the Push-Back Relief Test, Section 58, for the wiring in the accessory if there is a possibility of transmitting stress to the terminal connections during installation.

7.6 effective April 7, 2014

7.7 All terminals and wiring intended to be field connected shall be identified on the accessory, on the mounting device if connections are made between the mounting device and the apparatus, and on the wiring diagram.

7.7 effective April 7, 2014

7.8 The intended installation of the accessory shall be indicated in the installation instructions included on or with the accessory. See 72.3.

7.8 effective April 7, 2014

7.9 As part of the investigation, an accessory is to be trial installed to determine that the installation is feasible, the instructions are detailed and correct, and the use of the accessory does not introduce a risk of electric shock, fire, or injury to persons.

7.9 effective April 7, 2014

ELECTRICAL CONSTRUCTION

8 General

8.1 A mount system that employs an electromagnetic interference filter shall also comply with the Standard for Electromagnetic Interference Filters, UL 1283. A product that employs a transient voltage surge suppressor shall also comply with the Standard for Surge Protective Devices, UL 1449. Telephone equipment and communication circuit protectors included in a mounting system shall comply with the requirements in the Standard for Information Technology Equipment – Safety – Part 1: General Requirements, UL 60950-1, and the requirements in the Standard for Secondary Protectors for Communications Circuits, UL 497A, respectively. A mounting system that incorporates an antenna discharge unit or provides antenna connections to a television, a high-voltage video product, or antenna shall comply with the applicable requirements in the Standard for Antenna Discharge Units, UL 452, and the Standard for Audio-Video Products and Accessories, UL 1492. A product that employs ground-fault protection shall comply with the requirements in the Standard for Ground-Fault Circuit Interrupters, UL 943.

8.1 effective April 7, 2014

8.2 Portable luminaires used in a mount system covered by this standard shall comply with the requirements in the Standard for Portable Electric Luminaires, UL 153. Non-portable luminaires shall comply with the Standard for Luminaires, UL 1598.

8.2 effective April 7, 2014

8.3 Safety Circuits employing solid-state devices shall comply with the Standard for Tests for Safety-Related Controls Employing Solid-State Devices, UL 991. Mounting systems that incorporate neon lamps shall also comply with the Standard for Neon Transformers and Power Supplies, UL 2161.

8.3 effective April 7, 2014

8.4 A mount system shall be completely wired with each electrical component mounted in place and with each splice and connection completed or as indicated below:

- a) A detachable power-supply cord may be disconnected from the product, provided it is packaged with the product.
- b) A mounting system that is disassembled for shipping may be provided with mating connectors that are keyed to maintain correct polarity and can be assembled by hand.

8.4 effective April 7, 2014

9 Electrical Enclosures

9.1 A mounting system 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.

9.1 effective April 7, 2014

9.2 For unreinforced, flat surfaces in general, cast metal shall not be less than 1/8 in (3.2 mm) thick, except that malleable iron may be not less than 3/32 in (2.4 mm) and die cast metal may be not less than 5/64 in (2.0 mm) thick. Corresponding thicknesses of not less than 3/32 in, 1/16 in (1.6 mm), and 3/64 in (1.2 mm), respectively, may be acceptable if the surface under consideration is curved, ribbed, or otherwise reinforced, or if the shape or size, or both, of the surface is such that the necessary mechanical strength is provided.

9.2 effective April 7, 2014

9.3 An enclosure of sheet metal shall be judged with respect to its size, shape, thickness of metal, and its application, considering the intended use of the complete appliance. Sheet steel having a thickness of less than 0.026 in (0.66 mm) if uncoated or 0.029 in (0.74 mm) if galvanized or of nonferrous sheet metal having a thickness of less than 0.036 in (0.91 mm) shall not be used, except for relatively small areas or for surfaces that are curved or otherwise reinforced and tested according to the Electrical enclosure impact test, 61.2.

9.3 effective April 7, 2014

9.4 Sheet metal to which a wiring system is to be connected in the field shall have a thickness not less than 0.032 in (0.81 mm) if uncoated steel, not less than 0.034 in (0.86 mm) if galvanized steel, and not less than 0.045 in (1.16 mm) if nonferrous.

9.4 effective April 7, 2014

9.5 Among the factors that shall be taken into consideration when judging a nonmetallic enclosure are resistance to:

- a) Mechanical damage;
- b) Impact;
- c) Moisture-absorption;
- d) Combustion; and

e) Distortion at temperatures to which the material may be subjected under conditions of normal or abnormal use.

9.5 effective April 7, 2014

9.6 An electrical enclosure of polymeric material shall comply with the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. A cord and plug connected mounting system shall be considered under UL 746C path II – (portable attended and unattended commercial equipment, and portable unattended household equipment). Permanently connected mounting systems shall be considered under UL 746C path III – (all other Equipment).

9.6 effective April 7, 2014

9.7 Operating parts, such as gear mechanisms, relays, and similar devices, shall be enclosed to protect against malfunction from dust or from other material that may impair their intended operation and to reduce the risk of fire, electric shock, or injury to persons. (See also Section 48.1, Mechanical enclosures and guards.)

9.7 effective April 7, 2014

9.8 A mount shall be constructed so that all user servicing is completed without subjecting any wiring, component, or part, to mechanical damage, or reducing electrical spacings.

9.8 effective April 7, 2014

9.9 A decorative part, the failure of which does not result in a risk of fire, electric shock, or injury to persons, is permitted to be constructed of any material.

9.9 effective April 7, 2014

10 Enclosure Openings

10.1 An electrical enclosure shall reduce the risk of molten metal, burning insulation, flaming particles, or the like, from falling on combustible materials, including the surface upon which the mounting system is supported.

10.1 effective April 7, 2014

10.2 The requirement in 10.1 will necessitate that a switch, a relay, a solenoid, or the like be individually and completely enclosed, except for terminals, unless it can be shown that malfunction of the component would not result in a risk of fire, or there are no openings in the bottom of the mounting system enclosure. It will also necessitate the use of a barrier of noncombustible material under a motor unless:

- a) The structural parts of the motor or of the mounting system provide the equivalent of such a barrier;
- b) The protection provided with the motor is such that no burning insulation or molten material falls to the surface that supports the mounting system when the motor is energized under each of the following fault conditions:
 - 1) Open main winding;
 - 2) Open starting winding;
 - 3) Starting switch short-circuited; and
 - 4) Capacitor of permanent-split capacitor motor short-circuited – the short circuit is to be applied before the motor is energized, and the rotor is to be locked;

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c) The motor complies with the requirements in the Standard for Overheating Protection for Motors, UL 2111, the Standard for Impedance Protected Motors, UL 1004-2, or the Standard for Thermally Protected Motors, UL 1004-3, and the temperature of the motor winding will not exceed 150°C during the first 72 h of operation with the rotor of the motor locked; or

d) Under wiring, unless it is rated VW-1.

10.2 effective April 7, 2014

10.3 A part such as a splice connection, a wire, a transformer, a capacitor, a ballast, a current-carrying part, or a device with an exposed live part shall be contained in an enclosure.

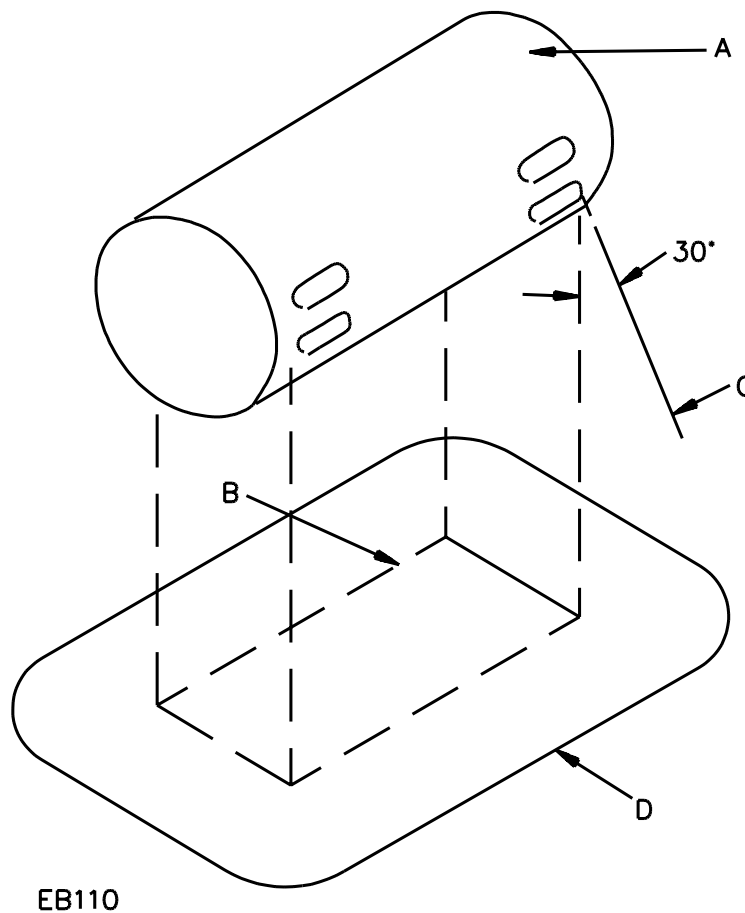
10.3 effective April 7, 2014

10.4 The barrier mentioned in 10.2 shall be located as illustrated in Figure 10.1, and shall not have an area less than that described in that illustration. Openings for drainage, ventilation, and the like may be employed in the barrier, provided such openings would not permit molten metal, burning insulation, or the like to fall on combustible material.

10.4 effective April 7, 2014

Figure 10.1
Location and extent of protective barrier

Figure 10.1 effective April 7, 2014



A – The entire component under which a barrier (flat or dished, with or without a lip or other raised edge) of nonflammable material is to be provided. The sketch above is of a metal enclosed component with ventilating openings to show that the protective barrier is required only for those openings from which flaming parts might come. If the component or assembly does not have its own nonflammable enclosure, the area to be protected would be the entire area occupied by the component or assembly.

B – Projection of the outline of the area of (A) which needs a bottom barrier vertically downward onto the horizontal plane of the lowest point on the outer edge (D) of the barrier.

C – Inclined line that traces out an area (D) on the horizontal plane of the barrier. Moving around the perimeter of the area (B) which needs a bottom barrier, this line projects at a 30-degree angle from the line extending vertically at every point around the perimeter of (A) and oriented to trace out the largest area, except that the angle may be less than 30 degrees if the barrier or portion of the bottom cover contacts a vertical barrier or side panel of nonflammable material, or if the horizontal extension of the barrier (B) to (D) would exceed 6 inches (152 mm).

D – Minimum outline of the barrier, except that the extension B-D need not exceed 6 inches (flat or dished, with or without a lip or other raised edge). The bottom of the barrier may be flat or formed in any manner if every point of area (D) is at or below the lowest point on the outer edge of the barrier.

10.5 An opening in the mounting system provided for hanging shall be located or guarded so that a nail, hook, or the like does not displace a part that would create a risk of fire or electric shock, and does not contact one of the following:

- a) An uninsulated live part.
- b) Magnet wire.
- c) Internal wiring.
- d) Moving parts.
- e) Any other part likely to create a risk of fire or electric shock.

10.5 effective April 7, 2014

10.6 Louvers and other openings in the enclosure shall be constructed and located to reduce the risk of contact by persons with uninsulated high-voltage live parts as indicated below:

- a) Parts such as covers, panels, and grilles used as part of the enclosure are to be removed unless tools are required to remove the cover, panel or grill.
- b) Covers, panels, and grilles are to be opened if it is intended that a user is to make adjustments under a cover, panel or grill while energized.
- c) A safety interlock system may be provided that deenergizes uninsulated high-voltage live parts and/or mitigates the risk of pinching and crushing when the cover, panel or grill is removed.

10.6 effective April 7, 2014

10.7 A component that has an integral outer housing that has been evaluated as an enclosure is not required to be additionally enclosed.

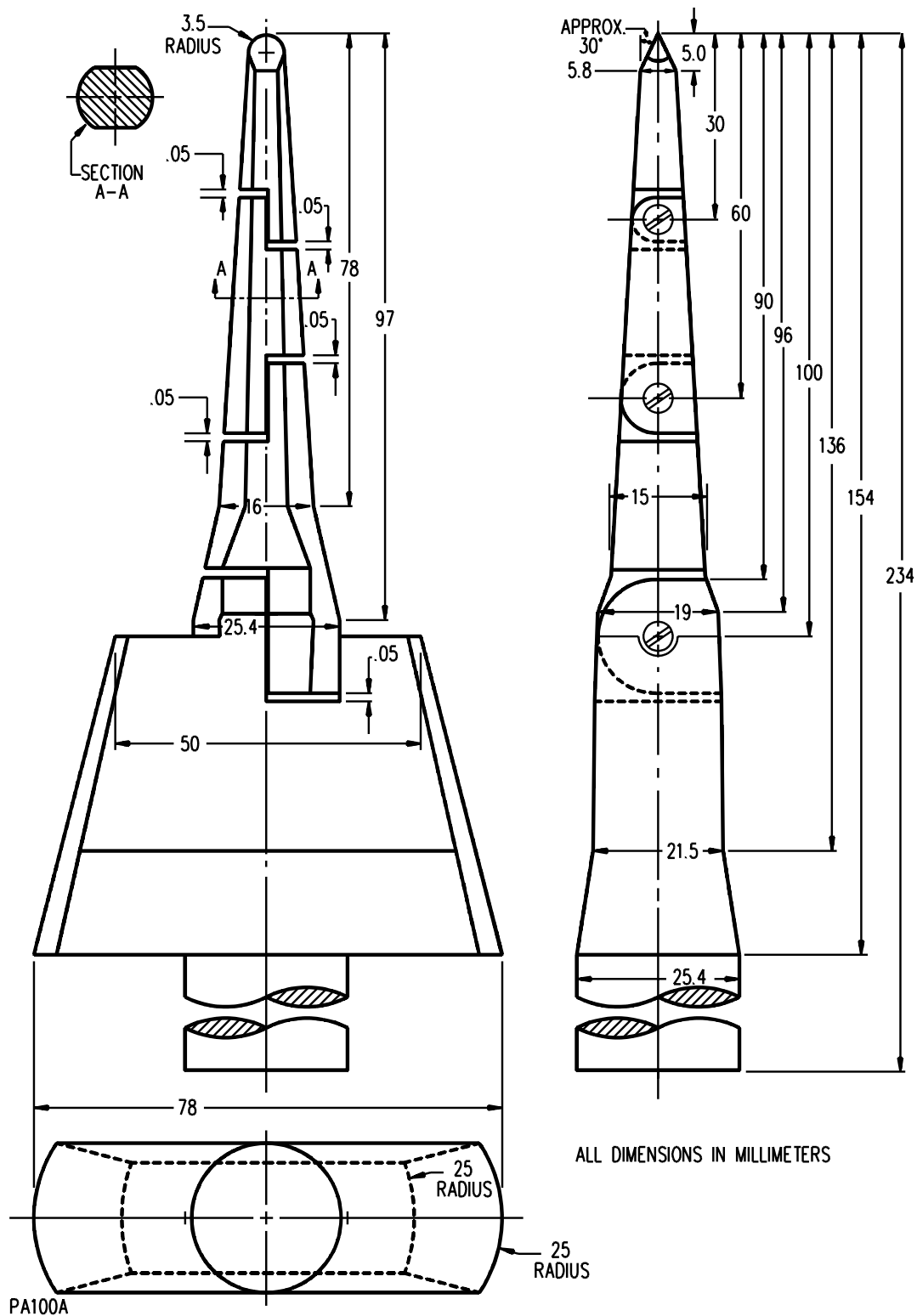
10.7 effective April 7, 2014

10.8 An uninsulated live part is determined to be inaccessible when a probe as illustrated in Figure 10.2 is unable to be manipulated such that it touches any uninsulated live part. The probe is to be articulated into any configuration and rotated or angled to any capable position before, during, or after inserting into the opening.

10.8 effective April 7, 2014

Figure 10.2
Articulate probe with web stop

Figure 10.2 effective April 7, 2014



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10.9 A current-carrying part of a wiring device (such as the screw shell and center contact of a lampholder, the lampholder contacts, starter holder contacts, or similar components of a fluorescent lamp) that is normally fitted with a functional component (a lamp, a starter, or similar component) during use of the mounting system is not required to be additionally enclosed.

10.9 effective April 7, 2014

10.10 An uninsulated live part that operates at a potential of 30 volts rms (42.4 volts peak) and supplied by a Class 2, LPS or SELV power source is able to be accessible.

10.10 effective April 7, 2014

10.11 The following are not considered to be uninsulated live parts:

- a) Coils of relays and solenoids, transformer and ballast windings only if the coils, windings, cross-over leads and primary and secondary supply leads are provided with insulation rated for the Temperature, Voltage and Current.
- b) Terminals and splices with insulation rated for the Temperature, Voltage and Current.
- c) Insulated wire – Rated for the Temperature, Voltage and Current.
- d) Edison-based lamp holders.

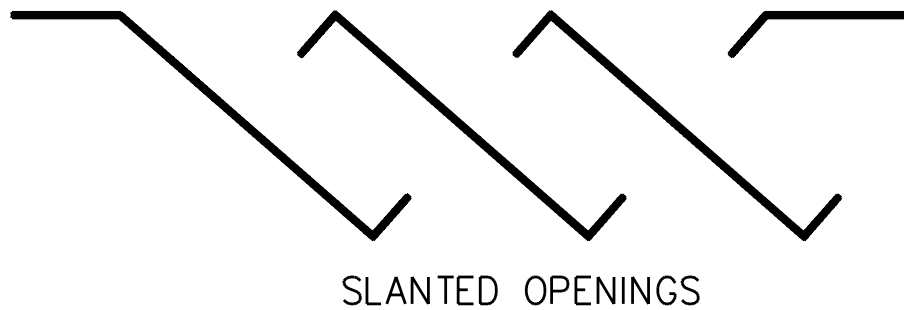
10.11 effective April 7, 2014

10.12 Openings in the enclosure shall be constructed and sized to reduce the risk of direct entry of foreign objects. See Figure 10.3 for examples of acceptable top cover constructions. See also Figures 10.4 and 10.5 for examples of acceptable side openings.

10.12 effective April 7, 2014

Figure 10.3
Top cover designs

Figure 10.3 effective April 7, 2014

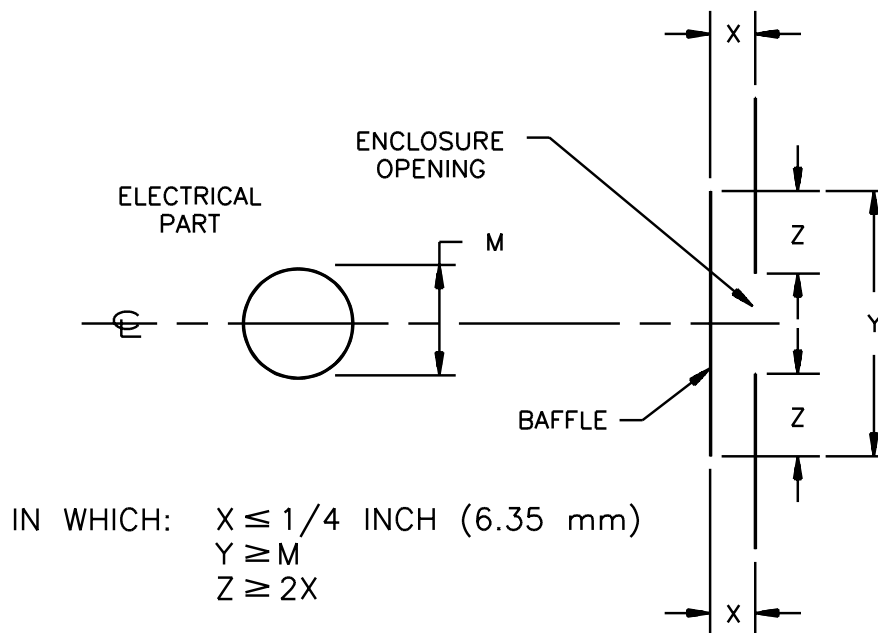


EC500

VERTICAL OPENINGS

Figure 10.4
Relationship of baffle and electrical part to prevent emission

Figure 10.4 effective April 7, 2014



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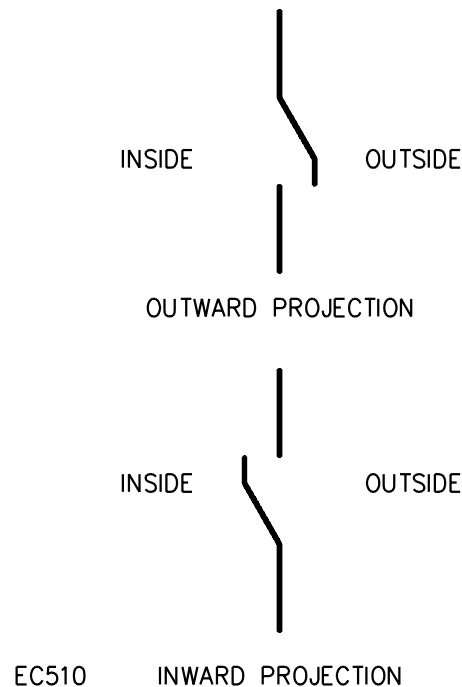
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Figure 10.5
Louver designs

Figure 10.5 effective April 7, 2014



10.13 An opening in a bottom panel or protective pan may be used if the following conditions are met:

- a) The interior above the panel or pan contains no material classified as HB, V-2 or V-1 in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.
- b) The panel or pan by its construction prevents materials from falling from the interior of the product directly onto the supporting surface or anything else under the product. Positions of movable components shall be considered. Manufacturers installation instructions shall be used for the proper positioning of adjustable pans and panels.

10.13 effective April 7, 2014

10.14 Openings may be used, without limitation of the size or number of openings, in areas where:

- a) The mounting system wiring material is rated VW-1;
- b) Plugs, receptacles and connectors are constructed of V-0, 5VA or 5VB rated material; and
- c) Underneath impedance protected or thermally protected motors.

10.14 effective April 7, 2014

10.15 The bottom of the enclosure under areas containing only materials classified as V-0, 5VA, or 5VB, or less flammable, may have openings not larger than $1/16$ in² (40.3 mm²).

10.15 effective April 7, 2014

11 Screens and Expanded Metal

11.1 A screen or mesh of expanded metal used as a guard, enclosure, or part of an enclosure, shall comply with the requirements of 11.2 – 11.4 and with the Electrical enclosure impact test, 61.2.

11.1 effective April 7, 2014

11.2 Perforated sheet steel or sheet steel used for expanded metal mesh shall not be less than 0.042 inch (1.07 mm) in thickness [0.045 inch (1.17 mm) if zinc coated] if the mesh openings or perforations are $1/2$ in² (323 mm²) or less in area. For larger openings, the steel shall not be less than 0.080 inch (2.03 mm) in thickness [0.084 inch (2.13 mm) if zinc coated]. The largest dimension shall not exceed 4 inches (102 mm).

11.2 effective April 7, 2014

11.3 With reference to the requirements in 11.2, expanded steel mesh or perforated sheet steel that is 0.020 inch (0.53 mm) thick [0.023 inch (0.58 mm) thick if zinc coated] may be used if the indentation of a guard or the enclosure will not alter the clearance between uninsulated live parts and grounded metal so as to impair performance or reduce spacings below the minimum required values (see Electrical Spacings, Section 14). If this is the case, then either:

a) The exposed mesh on any one side or surface of the product so protected shall have an area of not more than 72 in² (464 cm²) and no dimension greater than 12 inches (305 mm); or

b) The width of an opening so protected shall not be greater than 3-1/2 inches (89 mm).

11.3 effective April 7, 2014

11.4 The wires of a screen shall not be less than 16 AWG (1.29 mm diameter) steel if the screen openings are $1/2$ in² (323 mm²) or less in area and shall not be less than 12 AWG (2.05 mm diameter) steel for larger screen openings.

11.4 effective April 7, 2014

12 Doors and Covers

12.1 A part of an enclosure, such as a door or a cover, shall be provided with a means – such as latches, locks or screws – for firmly securing it in place.

12.1 effective April 7, 2014

12.2 An enclosure shall be provided with a door when it gives access to a fuse or any other overload protective device that requires renewal or when it is required to be opened in connection with the user servicing or installation of the device.

Exception: A door is not required for an enclosure:

a) In which the only fuse enclosed is a control-circuit fuse, when the fuse and control-circuit load – other than a fixed control-circuit load, such as a pilot lamp – are within the same enclosure; or

b) In which a means is provided for resetting all overload-protective devices from outside the enclosure, or kits are available to provide a means for resetting all overload-protective devices from outside the enclosure.

12.2 effective April 7, 2014

12.3 A door provided in accordance with the requirement in 12.2 shall be provided with a snap latch or a captive multi-turn or partial-turn fastener. Such securing means shall be located or used in multiple so as to hold the door closed over its entire length. A captive fastener shall be operable by hand or by a simple hand tool such as a screwdriver.

12.3 effective April 7, 2014

12.4 A door more than 48 inches (1.2 m) long on the hinged side shall be provided with one of the following:

- a) A multipoint latch operated by a single knob or handle;
- b) Two or more snap latches or captive fasteners; or
- c) One knob-operated latch and one snap latch or captive fastener.

12.4 effective April 7, 2014

12.5 Doors and covers of mechanical enclosures shall comply with Mechanical enclosures and guards, 48.1.

12.5 effective April 7, 2014

12.6 Doors and covers of mechanical and electrical enclosures shall comply with Doors and Covers, Section 12, and Mechanical enclosures and guards, 48.1.

12.6 effective April 7, 2014

13 Screws and Mechanical Connections for Electrical Enclosures

13.1 Screwed connections, electrical or otherwise, shall withstand the mechanical stresses occurring in normal use. Screws transmitting contact pressure and screws that are likely to be tightened by the user and have a nominal diameter less than No. 6 (3 mm) shall screw into metal. Screws shall not be of metal which is soft or liable to creep, such as zinc or pure aluminum. Screws of polymeric material shall have a nominal diameter of at least No. 6 (3 mm); they shall not be used for any electrical connection. Screws shall not be of insulating material if their replacement by a metal screw could impair supplementary insulation or reinforced insulation, neither shall screws which may be removed when replacing a power supply cord or undertaking other routine servicing, be of insulating material if their replacement by a metal screw could impair electrical insulation. Screws or nuts which are likely to be tightened by the user include terminal screws or nuts, screws for fixing covers and position of the mount, screws that have to be loosened to open or to remove the cover or reposition the apparatus support, and screws for fixing handles and knobs.

13.1 effective April 7, 2014

13.2 Screws in engagement with a thread of insulating material shall have a length of engagement of at least 1/8 inch (3 mm) plus one-third of the nominal screw diameter, or 5/16 inch (8 mm), whichever is the shorter.

13.2 effective April 7, 2014

14 Electrical Spacings

14.1 The spacing between uninsulated live parts of opposite polarity, and between uninsulated live parts and metal that is capable of being grounded shall not be less than 1/4 inch (6.4 mm) through air or 3/8 inch (9.5 mm) over surface. See Figure 14.1.

Exception No. 1: See 3.1, the spacing requirements do not apply between uninsulated live parts of a component, such as a lampholder or switch, and dead metal that is part of the component.

Exception No. 2: See Sections 31 and 32, the spacing between uninsulated live parts on the output of a NEC Class 2, LPS or SELV power supply and between such parts and dead metal that is grounded in service is not specified.

14.1 effective April 7, 2014

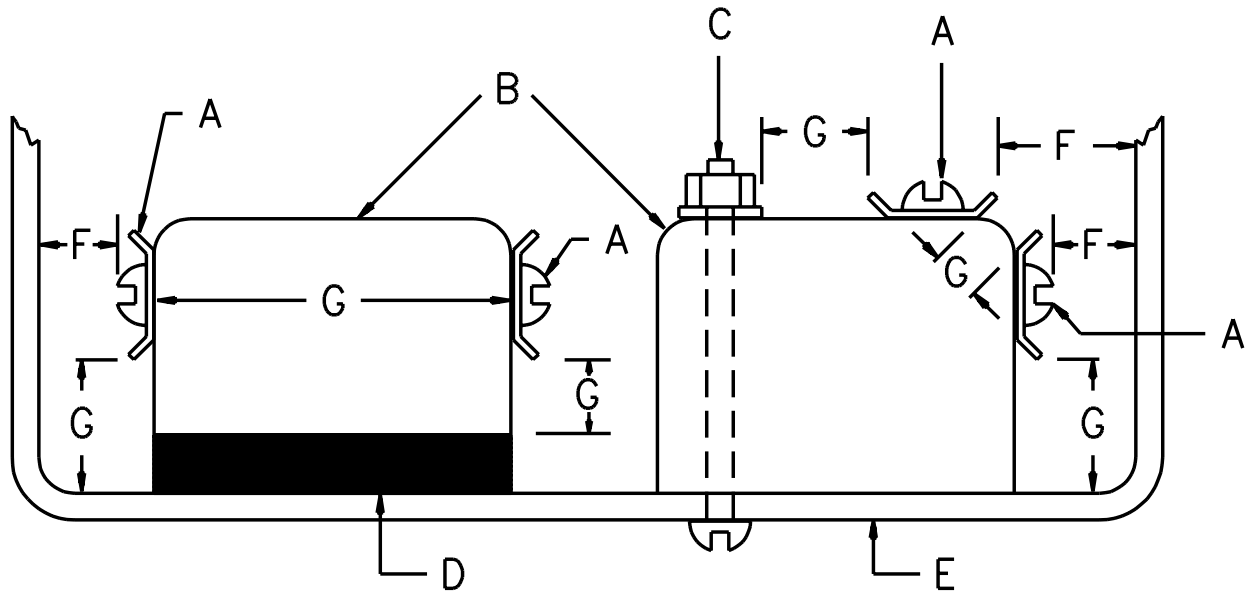
14.2 As an alternate to 14.1, the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840, may be used to determine electrical spacing. This only applies to conductive parts that are rigidly held in place and reliably spaced in production such as conductors and components on a printed wiring board. The spacing requirements in UL 840 shall not be used for spacing to a dead metal enclosure, or to uncontrolled components such as wiring device terminals, transformers, and ballasts. Creepage distances shall not be less than clearances. When using the requirements specified in UL 840, the following conditions apply:

- a) A mounting system marked for wet locations or requiring the humidity conditioning test shall be considered exposed to environmental pollution degree 3 and over voltage category of II.
- b) A mounting system other than (a) shall be considered exposed to environmental pollution degree 2 and over voltage category of II.
- c) The portion of a printed wiring board covered with a potting compound or a conformal coating that complies with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluation, UL 746C, shall be considered exposed to environmental pollution degree 1 and over voltage category of II.

14.2 effective April 7, 2014

Figure 14.1
Spacings of components

Figure 14.1 effective April 7, 2014



SM100

- A. Uninsulated live parts of wiring device.
- B. Insulating material of wiring device.
- C. Mounting screw of wiring device.
- D. Dead metal part of wiring device.
- E. Dead metal parts of mount or mount display.
- F. Spacings to which Figure 14.1 applies.
- G. Spacings to which Figure 14.1 does not apply.

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14.3 When an uninsulated live part is not rigidly fixed in position by means other than friction between surfaces, or when a movable dead metal part is in proximity to an uninsulated live part, the construction shall be such that when the unfixed part is in any position, the required minimum spacing is maintained.

14.3 effective April 7, 2014

15 Electrical Insulating Materials

15.1 A polymeric material used as an electrical insulator, or as direct or indirect support of a live part, shall comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

15.1 effective April 7, 2014

16 Electrical Ratings

16.1 Each electrical device and insulated conductor shall have a voltage rating at least equal to the voltage applied to it in normal use.

16.1 effective April 7, 2014

16.2 Each electrical device shall have an ampere rating and each insulated conductor shall have an ampacity rating for the maximum current to which it is subjected in normal use.

16.2 effective April 7, 2014

16.3 The ampere rating of the mounting system shall be calculated by adding the ratings of all of the following that are provided on the unit:

- a) The marked ampere rating on each receptacle;
- b) The ampere rating of each ballast;
- c) The calculated load of each line voltage incandescent lampholder is to be determined by dividing the marked wattage rating by 115 volts;
- d) The ampere rating of each transformer; and
- e) The ampere rating of any other line-voltage parts, such as a clock, a motor, and similar parts.

16.3 effective April 7, 2014

16.4 The maximum ampacity rating of an insulated conductor shall be as specified in Table 16.1.

16.4 effective April 7, 2014

Table 16.1
Ampacities of wires and cords with copper conductors

Table 16.1 effective April 7, 2014

Types of wire and cord ^a	Ampacity			
	18 AWG (0.82 mm ²)	16 AWG (1.3 mm ²)	14 AWG (2.1 mm ²)	12 AWG (3.3 mm ²)
Fixture wires	6	8	17	23
Flexible cords – As specified in Table 21.1	10	13	18	25
Appliance wiring material	6	8	17	23
^a Some of the types of wire and cord are not made in each of the sizes shown. For each such type and size, the ampacity shown is inapplicable.				

17 Wiring and Conductors – Conductor Size

17.1 A conductor of a wire or cord shall be 18 AWG (0.82 mm²) or larger. See Electrical Ratings, Section 16.

17.1 effective April 7, 2014

17.2 A conductor smaller than 18 AWG (0.82 mm²) is able to be used for internal wiring when it is investigated and found to meet the requirements for the intended application; for example, consideration is to be given for internal fusing, lead routing, and degree of enclosure required under any condition of loading, including short circuit and abnormal operation.

17.2 effective April 7, 2014

17.3 A conductor in a high-voltage circuit smaller than 18 AWG (0.82 mm²) and not smaller than 24 AWG (0.21 mm²) is usable as a permanently attached lead for a motor, transformer or other load when:

- a) The lead is completely enclosed;
- b) Stalling of the motor, or any load on the secondary of the transformer, including a short circuit, does not result in a risk of fire; and
- c) The lead may pass over openings in the enclosure provided the wire cannot be contacted by the probe in Figure 10.1 and it is rated VW-1.

17.3 effective April 7, 2014

17.4 A conductor smaller than 18 AWG (0.82 mm²) is usable in a low-voltage Class 2 power-limited circuit.

17.4 effective April 7, 2014

17.5 Wiring or cord rated 90°C (194°F) is suitable up to 150°C (302°F) when each individual conductor is provided with a glass insulation extending from the terminals of the heat producing component a minimum of 3 inches (76 mm) as indicated below:

- a) Consisting of snug fitting woven-glass sleeving not less than 0.010 inch (0.25 mm) thick; or
- b) Woven-glass electrical tape applied in two or more layers having a total thickness of not less than 0.010 inch.

17.5 effective April 7, 2014

18 Splices and Connections

18.1 All internal wiring terminations shall be mechanically secured, provide electrical continuity and shall be soldered unless provided with pressure wire connectors that comply with the Standard for Splicing Wire Connectors, UL 486C, or the Standard for Electrical Quick-Connect Terminals, UL 310, or the Standard for Terminal Blocks, UL 1059.

18.1 effective April 7, 2014

18.2 A soldered splice and a splice made with an uninsulated wire connector shall be covered with insulation that has a voltage and temperature rating equivalent to that required on the conductors.

18.2 effective April 7, 2014

18.3 An insulated wire connector shall be rated for the required voltage and temperature of the conductors involved.

18.3 effective April 7, 2014

18.4 A soldered joint shall be mechanically secured before soldering by being:

- a) Wrapped at least halfway (180 degrees) around a terminal;
- b) Provided with at least one right angle bend when passed through an eyelet or opening; or
- c) Twisted with other conductors.

18.4 effective April 7, 2014

18.5 A connection to a wire-binding screw shall be made as follows such that no loose strands protrude from the connection:

- a) Solid wire formed into a loop at least three-quarters (270 degrees) around the terminal; or
- b) Stranded wire that is:
 - 1) Soldered;
 - 2) Connected to a terminal provided with upturned ends;
 - 3) Connected to a terminal provided with a cup washer; or
 - 4) Connected to a crimped pressure terminal connector or eyelet.

18.5 effective April 7, 2014

18.6 A connection to a terminal of a component shall be made by:

- a) Wire inserted directly into a pressure wire terminal of the component;
- b) Quick-connect terminal of the component, where the mating part is provided with a dimple, depression, or spring-type connection such that a mechanical snap-action connection is made that does not rely solely upon friction between the two parts;
- c) Crimped-on pressure terminal connector or closed-loop eyelet;
- d) Solder terminal;

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- e) Wire-binding screw; or
- f) Open-type eyelet.

18.6 effective April 7, 2014

18.7 An open-type eyelet shall have:

- a) Upturned ends that engage the terminal screw head;
- b) Fork- or crimp-type ends that engage the terminal screw shank; or
- c) A flat terminal that supports the wire such that loosening of a terminal screw does not result in the conductor disengaging from the intended connection.

18.7 effective April 7, 2014

18.8 Multiple conductors secured to a single termination point shall result in a reliable electrical and mechanical connection made without loose, unretained, or severed stranding, and without a reduction in the electrical spacings.

18.8 effective April 7, 2014

18.9 Uninsulated live parts shall be secured to their supporting surfaces so that they are prevented from turning or shifting in position when such motion results in a reduction of spacings to less than those indicated in Electrical Spacings, Section 14.

18.9 effective April 7, 2014

19 Wiring Attached to Movable or Flexible Parts

19.1 Internal wiring attached to or routed through a movable or a flexible part shall have stranded conductors and be secured so that the wiring is not cut or abraded and shall be routed and supported so that there is no strain or motion at the splice or connections.

19.1 effective April 7, 2014

19.2 Type SV, SVO, SVOO, SVT, SVTO, or SVTOO cord shall not be attached to a movable or a flexible part that bends the cord in a radius less than 20 times its diameter.

19.2 effective April 7, 2014