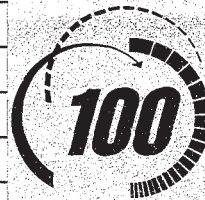


Fluorescent Lighting Fixtures

JUL 31 1995

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July 25, 1995

Standard for

Fluorescent Lighting Fixtures

UL 1570, Fourth Edition

Accompanying this transmittal notice is a copy of the Fourth edition of UL 1570.

THIS EDITION OF THE STANDARD IS NOW IN EFFECT.

Attention is directed to the note on the title page of this standard identifying that the Department of Defense has adopted the text of UL 1570.

Revised and/or additional pages may be issued from time to time.

JULY 25, 1995

1

UL 1570

Standard for

Fluorescent Lighting Fixtures

Prior to the first edition, the requirements for the products covered by this standard were included in the Standard for Electric Lighting Fixtures, UL 57.

First Edition – April, 1979
Second Edition – November, 1982
Third Edition – April, 1988

Fourth Edition

July 25, 1995

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

The Department of Defense (DoD) has adopted UL 1570 on January 18, 1985. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

PART 1 – ALL FIXTURES

INTRODUCTION

1 Scope

1.1 These requirements cover general use fluorescent electric lighting fixtures for commercial, industrial, or residential use in ordinary locations in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements do not cover:

- a) Fixtures for installation aboard a ship or boat;
- b) Fixtures for underwater installation;
- c) Fixtures for use in hazardous locations as defined in the National Electrical Code, NFPA 70;
- d) Portable lamps;
- e) Miscellaneous special purpose units, such as inspection lights, photographic lights, sewing-machine lights, garden lights, portable electric hand lamps, stage and studio lights, and medical and dental lights;
- f) Fixtures involving a potential of over 1000 volts;
- g) Emergency lighting fixtures, fixtures with integral batteries, or exit fixtures;
- h) Fixtures provided with adapters or other forms of construction that enable them to be mounted on, or supported by any other fixture, lampholder, or receptacle;
- i) Fixtures intended for field mounting to furniture as part of a cord-connected task lighting assembly;
- j) Lighting units having flashing characteristics, words, or symbols designed to convey information or attract attention (exclusive of exit lighting);
- k) Low voltage fixtures for use in recreational vehicles that are supplied solely by nominal automotive battery voltage.

1.3 A fixture provided with lampholders for both incandescent and fluorescent lamps (a combination incandescent-fluorescent lamp fixture) shall comply with the requirements of this standard and with requirements in the Standard for Incandescent Lighting Fixtures, UL 1571, insofar as they apply to construction, test methods, and marking requirements unique to incandescent lamps.

1.4 A fixture provided with lampholders for both fluorescent and high intensity discharge lamps (a combination fluorescent-high intensity discharge lamp fixture) shall comply with requirements in the Standard for High Intensity Discharge Lighting Fixtures, UL 1572, and with the requirements of this standard insofar as they apply to construction, test methods and marking requirements unique to fluorescent lamps.

1.5 A bathroom cabinet fixture is judged under the general requirements and under the applicable requirements for Metal Thickness in Section 9 and ventilation openings in 42.3.4 and 42.3.6.

1.6 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this Standard, and that involve a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this Standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this Standard cannot be judged to comply with this Standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

2 General

2.1 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.

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

3 Glossary

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

3.2 BALLAST, HIGH POWER FACTOR – A reactor-type ballast marked to indicate it is of the high power factor type or marked for a power factor of 0.9 or higher.

3.3 BALLAST, OUTDOOR – A ballast marked:

- a) "Type 1" or "T1" must be installed in a fixture enclosure complying with the requirements of 8.1.
- b) "Type 2" or "T2" must be installed in the fixture enclosure to prevent the entry of water into the ballast.
- c) "Weatherproof" or "WP" requires no additional enclosures mentioned by (a) and (b).

3.4 BALLAST, REACTOR, (SIMPLE REACTANCE) – A reactance type ballast in which the lamp ballasting impedance is provided by a single coil inductor – not a transformer or inductor with additional components.

3.5 CANOPY – A cover type device provided separately or with a fixture that is used to cover the outlet box by securing to the outlet box or ceiling.

3.6 CANOPY, DROP – A canopy that can be lowered for access to the supply connections without lowering the fixture. The canopy does not support the fixture.

3.7 DIAGRAM, CIRCUIT – A line drawing, graphic design, and/or written instructions that explain the process of identifying conductors and making supply connections between the fixture and the branch circuit.

3.8 FLAT GLASS – A glass panel, usually formed from sheet stock, the overall shape of which (not necessarily the surface) is essentially flat. The panel may have a slight curvature or bend(s).

3.9 GASKET – A preformed resilient material used between two rigid surfaces.

3.10 KNOCKOUT – A partially cut out opening that is closed until the precut material is removed.

3.11 **OPENING** – A hole in the wall of a required enclosure. The opening may be either an open hole or a knockout.

3.12 **OPEN HOLE** – An opening without a cover or similar closure material.

3.13 **PENDANT FIXTURE** – A fixture that is supported by and suspended from an outlet box by chain, cord, stem, or cable.

3.14 **POLE** – An outdoor support of metal, wood, or the like, over 12 feet (3.66 m) tall, on which at least one lighting fixture is intended to be mounted by means of arms or fittings. The height of the support is as measured from ground level.

3.15 **POST** – An outdoor support of metal, wood, or the like, no more than 12 feet (3.66 m) tall, on which a lighting fixture is intended to be mounted (usually on top). The height of the support is as measured from ground level.

3.16 **POWER SUPPLY CORD** – A length of flexible cord provided with an attachment plug at one end.

3.17 **PRESSURE TERMINAL CONNECTOR** – A device that secures one or more wires to a terminal plate, stud, or similar device without the use of solder.

3.18 **RECESSED FIXTURE** – A fixture intended to be installed in a hole in a wall, ceiling, or in-ground surface such that all or part of the fixture is behind the mounting surface. The types of recessed fixtures are as follows:

Type IC – A fixture that is investigated and identified for installation in a cavity where thermal insulation will be in direct contact with the fixture.

Type Non-IC, – A fixture that is investigated and identified for installation in a cavity that may or may not be insulated. All insulation is intended to be spaced at least 3 inches (76.2 mm) from the sides of the fixture. Insulation is not intended to be provided over the top of the fixture. The recessed portions of the enclosure, other than at points of support, are intended to be spaced at least 1/2 inch (12.7 mm) from combustible material.

Type Non-IC, Suitable for Installation in Poured Concrete or In Ground – A fixture that is identified as a Type Non-IC fixture, but that may also be identified as suitable for installation in poured concrete or in ground.

Type Non-IC, Suitable for Installation Only in Poured Concrete or In Ground – A fixture that is investigated and identified for installation only in poured concrete or in ground.

Canopy Fixture – A fixture intended for installation through an opening in an outdoor canopy or marquee such as those used over gas station pumping islands and similar locations. This product is not intended for indoor use or outdoor installation in which thermal insulation would be employed.

3.19 **RECESSED HOUSING** – The metal of a recessed fixture that serves to close off the opening provided in a ceiling or wall surface to mount the fixture. It does not necessarily enclose wires or the like.

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

3.21 **STRAIN RELIEF DEVICE** – A knot, bushing, or equivalent device intended to prevent strain from being transmitted to a wire or cord at a termination point inside a fixture.

3.22 **SURFACE MOUNT FIXTURE** – A non-recessed fixture.

3.23 **SUSPENDED CEILING** – A part of a building structure that is located on the room side of the structural ceiling (for example, wood joisted or structural steel) and that generally provides a plenum area above it for wiring that may or may not be accessible by service personnel.

3.24 **SWITCH** – A device intended to open, close, or change connections in a circuit. It includes manual switches and electrically operated switches (relays) but does not include fuses or circuit breakers.

3.25 **WIRE-BINDING SCREW** – A screw used as a post around which a wire is terminated.

4 Components

4.1 Except as indicated in 4.2, a component of a product covered by this standard shall comply with the requirements for that component. See Appendix A for a list of standards covering components generally used in the products covered by this standard.

4.2 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.

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

4.4 Specific components are recognized as being incomplete 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 Assembly and Packaging

5.1 A fixture shall be completely wired, with all splices and connections made.

Exception No. 1: Wired fixture sections complying with Section 54 need not comply with this requirement.

Exception No. 2: Arm(s) of a fixture or stem(s) of a stem-pendant fixture may be disconnected from the body of the fixture if it is marked or provided with instructions as specified in 32.3.

Exception No. 3: A stem- or chain-pendant fixture, for which incomplete assembly for packaging or shipment is essential, may be shipped in a form that requires wiring after the fixture leaves the factory, but shall be unwired only to the extent required for shipping or packaging, if investigated and marked or provided with instructions in accordance with 34.1.5.

5.2 A fixture shall be constructed with all electrical components mounted in place.

Exception: A lampholder, or a lampholder attached to a structural part, may be unmounted (but not unwired) to facilitate packaging for shipment.

5.3 A fixture shall be completely assembled when shipped from the factory.

Exception No. 1: Separate channels and reflectors that comply with Section 49 may be unassembled (but not unwired) for shipment.

Exception No. 2: Fixture fittings that comply with Section 47 need not be completely assembled when shipped from the factory.

Exception No. 3: Wired fixture sections may be unassembled for shipment only to an extent that complies with Section 54, Wired Fixture Sections.

Exception No. 4: A stem- or chain-pendant fixture, or similar construction, for which incomplete assembly for packaging or shipment is essential, may be unassembled only to the extent necessary to facilitate packaging for shipment or to make connection to the power supply.

Exception No. 5: Wireway channels, diffusers, and other parts that do not support electrical components may be shipped unassembled if packed on a pallet, or the equivalent, with the remaining parts of the fixture included.

5.4 A fixture that employs metal thinner than specified in Table 9.1 shall be assembled to the degree that it was assembled during the tests in Metal Thickness Equivalency Tests, Section 31.

5.5 A fixture is to be shipped from the factory in a carton or as an unpackaged complete assembly. Unassembled parts, such as stems, chains, and the like, if required elsewhere in the standard to accompany the fixture, shall be included.

Exception No. 1: A lens or diffuser that does not provide structural or enclosure functions as required by 8.1 need not be included.

Exception No. 2: A fixture may be bulk packed if all unassembled parts are included.

5.6 A reflector kit is to be shipped from the factory in a single carton. All kit components and installation instructions shall be included.

Exception: Reflector kits may be bulk packed if every kit component or set of components is shipped in one or more cartons and each carton contains a set of installation instructions.

5.7 The carton referenced in 5.5 or 5.6 is a box of cardboard, pasteboard, shrink film, or the like (but not newspaper, wrapping paper, tissue paper, or similar materials). It need not be rectangular in form, since the so-called "pinch pack" of cardboard wrap with ends pinched together and stapled is considered a carton. Parts banded or otherwise secured to a carton need not be located inside the carton.

5.8 A part that must be removed to assemble stems or connect a fixture in the intended manner to the supply circuit need not be fastened, but the construction shall be such, and the hardware shall be provided, to permit a satisfactory field assembly.

5.9 A threaded joint, unassembled to the degree permitted in 5.3, shall comply with the requirements in 7.1 and 7.2, or such a joint shall be furnished with setscrews, lock washers, or locknuts.

CONSTRUCTION – MECHANICAL

6 General

6.1 Self-threading or sheet-metal screws shall not be used in aluminum, copper, or aluminum or copper alloys.

Exception No. 1: A self-threading or sheet-metal screw may be used if threads are not stripped when the screw is tightened with a torque of 30 pound force-inches (3.39 N·m), and the part supported by the screw is then subjected to a force equal to four times the weight of the part. The force is to be applied in a direction coincident with the axis of the screw without distress to the fastening means.

Exception No. 2: If the screw threads through such sheet metal into steel having a minimum thickness as specified in Table 9.1, the above requirement does not apply.

6.2 A sheet metal or self-threading screw shall not be used for mounting or support of a part (ballast, transformer, lampholder, starter holder, or the like) that weighs more than 7-1/2 pounds (3.4 kg).

Exception: Sheet-metal or self-threading screws may be used if the construction is investigated and found to be equivalent to other acceptable fastening means.

7 Joints

7.1 The method of making a joint between metal parts, and of fastening arms and supports, shall provide strength and rigidity and prevent turning that would result in movement of wires or wiring devices after the assembly is completed.

7.2 Friction alone between parts is not acceptable as a means to prevent turning. Turning shall be prevented by:

- a) The use of a lock washer;
- b) A locknut seated against another nut or metal surface; or
- c) By some other positive mechanical method where two parts mate by interference fit.

7.3 Sheet metal nuts may be used if supplied as part of an armored cable or flexible conduit and, if fabricated of heat-treated steel, may be used:

- a) For assembly;
- b) To prevent turning of threaded tubing no larger than 1/8-inch (3.2-mm) pipe size; and
- c) On bolts or studs that are no larger than 1/4 inch (6.4 mm) in diameter.

Exception: A sheet metal nut for bolts larger than 1/4 inch diameter may be used to prevent turning or loosening if it is not depended upon for mechanical strength.

7.4 The fastening means for securing telescoping parts in an adjustable telescoping arm may depend on friction alone if rotation between parts is limited to 360 degrees or less and rotation will not result in damage to conductor insulation.

8 Enclosures

8.1 All splices, taps, transformers, all current-carrying parts or devices with exposed live parts, and all leads or terminals for field connection of supply wires shall be enclosed in materials specified in 8.2.

Exception No. 1: A fixture intended to be surface-mounted and outlet-box connected may have an opening as specified in 37.1.1.

Exception No. 2: A lampholder need not be enclosed.

Exception No. 3: A component device, such as a transformer, that has an integral outer enclosure in compliance with 8.2 need not be additionally enclosed.

Exception No. 4: A fixture with an integral pole or post, such as a bollard fixture, intended for mounting on an inorganic surface, need not have a bottom surface enclosure if the inorganic surface acts as the bottom surface enclosure.

Exception No. 5: A pole or post-mounted fixture may be provided with an opening for supply leads if the opening is intended to be closed off by a pole, post or a mounting arm.

8.2 An enclosure as specified in 8.1 shall be constructed of metal, glass, ceramic, porcelain, or a polymeric material that complies with the requirements of Polymeric Materials, Section 59. The minimum thickness for metal shall be as specified in Metal Thickness, Section 9, and for glass, as specified in Glass, Section 11.

8.3 Enclosure parts shall be secured by positive mechanical interference fit such as screws, snap fit, welding, and the like. Friction alone between parts is not an acceptable means of securing enclosure parts.

Exception: An enclosure part may be secured by friction alone if it complies with the following:

- a) The enclosure part being secured by friction alone has no other electrical components secured to it such as a lampholder, switch, starter holder, and the like.*
- b) The enclosure part is not required to be removed during routine maintenance, such as for starter replacement, lamp replacement, and the like.*
- c) The friction between parts is sufficient to retain the enclosure part to the fixture when a 10 lb (4.54 kg) weight is applied to the enclosure part in accordance with the Weight Loading Test specified in SA4.6.2.*
- d) Where the enclosure part is required to be grounded in accordance with Grounding, Section 23, bonding continuity does not rely on friction alone between adjacent surfaces.*

8.4 After assembly, there shall be no open holes in a fixture enclosure as described in 8.1.

Exception: Open holes specified in Openings, Section 10, are acceptable.

9 Metal Thickness

9.1 Sheet metal

9.1.1 The thickness of sheet metal in a fixture or canopy shall be no less than indicated in Table 9.1.

Exception No. 1: The thickness of metal is not specified for:

- a) *A purely ornamental part;*
- b) *A reflector part that does not form part of the enclosure; or*
- c) *Any part not required to serve as the enclosure, provide structural integrity, or support a wiring device.*

Exception No. 2: A form of construction that employs metal that is thinner than specified in Table 9.1 may be used if investigated and found to comply with the applicable tests in Metal Thickness Equivalency Tests, Section 31.

9.1.2 The lengths noted in Table 9.1 are considered to be:

- a) The diameter of a circular fixture;
- b) The longest diameter of an elliptical fixture;
- c) The longest side of a triangular fixture;
- d) The diagonal of a rectangular fixture; and
- e) The longest diagonal of a multisided fixture.

9.1.3 Footnote b of Table 9.1 applies to any single surface or single flat sheet. Rigid members consisting of 1/2- by 1/2-inch (12.7- by 12.7-mm) 90-degree angle strips formed of sheet steel no less than 0.032 inch (0.81 mm) thick, or flat steel bars no less than 3/8 inch (9.6 mm) wide and 1/8 inch (3.2 mm) thick, may be used to reinforce and divide a large area into sections for which lighter metal may be used. Such reinforcement, unless along the longer dimension of the surface, is to be additionally secured to the adjacent sides of the enclosure. A single piece of sheet metal that is corner-bent to form an angle of no more than 120 degrees is considered to be reinforced along the bend, and its thickness may be based on the length of the largest flat surface involved.

9.1.4 The values for minimum thickness indicated in Table 9.1 apply to measurements made on a formed part prior to the application of paint, varnish, or other coatings.

Table 9.1
Thickness of sheet metal

Specific construction ^a		Minimum thickness of sheet metal			
		Uncoated steel		Zinc-coated steel	Copper, brass, or aluminum
		In.	(mm)	In.	(mm)
At Opening For Conduit Connection		0.026	(0.66)	0.029 (0.74)	0.032 (0.81)
Length More Than 26 inches (660 mm)	Component Support	0.026 (0.66)		0.029 (0.74)	0.032 (0.81)
	No Component Support	0.020 ^b		0.023 ^b	0.025 ^b
Length Not More Than 26 Inches (660 mm)	Component Support	0.020 (0.51)		0.023 (0.58)	0.025 (0.64)
	No Component Support	0.016 ^b		0.019 ^b	0.020 ^b
Length Not More Than 26 Inches (660 mm)	Component Support	0.020 (0.51)		0.023 (0.58)	0.025 (0.64)
	No Component Support	0.016 ^b		0.019 ^b	0.020 ^b
Recessed Housings		0.026 (0.66)		0.029 (0.74)	0.032 (0.81)
Canopy, Supporting:					
8 pounds (3.6 kg) or less ^c		0.016 (0.41)		0.019 (0.48)	0.020 (0.51)
More than 8 pounds ^{c,d}		0.020 (0.51)		0.023 (0.58)	0.020 (0.51)
Any convenience receptacle		0.020 (0.51)		0.023 (0.58)	0.020 (0.51)
Surface-Mounted Fixture, length not more than 15 inches (381 mm)		0.016 (0.41)		0.019 (0.48)	0.020 (0.51)
Transformer enclosure (Garden Light)		0.050 (1.27)		0.053 (1.35)	0.081 (2.05)
^a A component refers to an electrical device, such as lampholder, switch or the like. ^b Minimum acceptable thickness for forms of construction that have been found to provide the physical strength and protection contemplated by the requirement in 9.1.1. ^c The weight of lamps is not included. ^d The thickness may be the same as that required, for "8 pounds or less," if the rim is reinforced by turning the metal at least 180 degrees, or by turning a 1/8 inch (3.2 mm) or wider right angle flange at the rim.					

9.2 Extrusions

9.2.1 An extruded metal part shall comply with the thickness requirements for sheet metal as described in 9.1.1.

9.3 Tubing

9.3.1 The minimum wall thickness of tubing:

- a) With or without pressed (rolled) threads shall be 0.025 inch (0.64 mm); or
- b) With die-cut threads shall be 0.040 inch (1.02 mm).

9.4 Cast metal

9.4.1 The minimum thickness of cast metal shall be in accordance with Table 9.2.

Table 9.2
Minimum acceptable thickness of cast metal

Metal	At unreinforced areas exceeding 35 square Inches (226 cm ²)		At all other areas	
	Inch	(mm)	Inch	(mm)
Die-cast metal	5/64	2.0	3/64	1.2
Cast malleable iron or permanent mold cast aluminum	3/32	2.4	1/16	1.6
Other cast metal	1/8	3.2	3/32	2.4

10 Openings

10.1 The requirements of this section apply to acceptable openings in an enclosure as required in 8.1. All unused openings provided for purposes not specifically covered in 10.2, 10.3, or 43.2.1, or, for surface-mounted fixtures, not covered in 37.3.1 – 37.7.1, shall comply with the requirements for miscellaneous openings specified in 10.4 and 10.5.

10.2 An enclosure that contains one or more open coil type devices shall not have any open hole.

Exception No. 1: A surface-mounted fixture may have open holes as described in 37.3.3.

Exception No. 2: An enclosure may have an open hole no more than 1 inch (25.4 mm) in diameter for an automatic starter.

Exception No. 3: An open hole that is permitted elsewhere may be located 6 inches (152 mm) or more from the device, measured horizontally, when the fixture is mounted as intended. See 34.1.2 for marking requirements when the fixture can be mounted in more than one orientation.

10.3 An enclosure that contains a fuse mounted in an open-type fuseholder shall not have any open hole.

Exception: An open hole that is permitted elsewhere may be located 6 inches (152 mm) or more from the fuse, measured horizontally, when the fixture is mounted as intended. See 34.1.2 for marking requirements.

10.4 An open hole in the enclosure specified in 8.1 provided for miscellaneous purposes shall not exceed the dimensions specified in Table 10.1.

Table 10.1
Maximum size of miscellaneous open holes

Opening shape	Dimension		Maximum area	
	Inch	(mm)	Inch ²	(mm ²)
Slot ^a	3/8	9.6 (width)	1-1/2	9.68
Square	1/2	12.7 (side)	—	—
Round	1/2	12.7 (diameter)	—	—
Irregular	—	—	1-1/2	9.68

^a A slot between two assembled parts that does not exceed 1/32 inch (0.8 mm) in width need not comply with the area limitation.

10.5 The total area of one or more open holes shall not be more than 15 percent of the area of the surface in which it is located. This includes the wiring compartment or integral outlet box compartment.

10.6 A knockout shall be so secured that it will remain in place during routine handling, but can be readily removed without distortion of the enclosure.

11 Glass

11.1 A flat panel of glass, smooth or otherwise, shall have a minimum thickness as indicated in Table 11.1 and shall have an exposed area no greater than 1100 square inches (7097 cm²).

Exception No. 1: Tempered glass may be used, if it is treated so that, when broken, it will completely dice into fragments such that the weight of the ten largest "crack-free" fragments does not exceed the weight of 10 square inches (64.5 cm²) of the original test panel.

Exception No. 2: Glass that does not comply with the minimum thickness requirements in Table 11.1 may be used, if it has been investigated and found to be mechanically equivalent.

Table 11.1
Minimum glass thickness

Exposed area of glass panel				Minimum thickness of glass					
More than		No more than		Flat		Curved		With concentric ribs	
Inches ²	(cm ²)	Inches ²	(cm ²)	Inch	(mm)	Inch	(mm)	Inch	(mm)
0	0	150	968	0.083	2.11	0.083	2.11	0.083	2.11
150	968	500	3226	0.10	2.54	0.083	2.11	0.083	2.11
500	3226	1100	7097	0.14	3.56	0.10	2.54	0.10	2.54

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

Exception: If the dimension of the piece is longer in a direction along the rib than in a direction perpendicular to the rib, the measurement is to be made between the peak of a rib and the other side, or between the peak and an opposite valley.

11.3 The thickness of a glass lens, glass that is curved or bent, and glass having other shapes shall be as specified in Table 11.1:

- a) If the glass is used as an enclosure required in 8.1; or
- b) If the glass area is greater than 275 square inches (1774 cm²).

11.4 An exposed edge of glass that may be contacted during relamping, cleaning, or servicing shall be seamed, swiped, fire-polished, or similarly treated to eliminate sharpness.

12 Glass Support

12.1 Flat glass mounting means

12.1.1 Flat glass shall be secured in a frame by clips, or held by channels or adhesive. The mounting means shall comply with the requirements in 12.1.2 – 12.2.10.

Exception: Clips are not required if the glass is held in place by its own weight in a frame that is not hinged and that does not need to be moved for relamping, cleaning, or servicing.

12.1.2 A frame shall be provided on at least three sides of a glass panel that is more than 300 square inches (1935 cm²) or more than 26 inches (660 mm) long.

Exception No. 1: A frame need not be provided on only two sides if the glass has a metal stiffener along one edge or if metal bands, spaced no more than 26 inches apart, support the glass.

Exception No. 2: A glass panel that is more than 300 square inches but no more than 1100 square inches (7097 cm²) may be held in place by clips around two sides and top if the panel will be in a vertical position upon installation of the fixture and provided that the weight of the glass is supported by the bottom frame of the fixture, or equivalent means, when the glass is in its intended operating position and during relamping. See 34.1.2 for marking requirements when the fixture can be mounted in more than one position.

12.1.3 Clips or channels shall be provided to secure glassware in a frame that is hinged or that is removable without the use of tools.

12.1.4 A frame that supports a glass panel greater than 300 square inches (1935 cm²) and that must be opened for relamping shall be provided with two or more hinges and a positive latch. A positive latch requires a definite lifting, twisting, or equivalent motion.

Exception No. 1: A single piano-type hinge may be used if the length of the hinge is no less than 65 percent of the length of the side of the frame to which it is attached.

Exception No. 2: A framed glass panel that is no more than 500 square inches (3226 cm²) need not be hinged if it can be kept within and supported by the fixture during relamping.

Exception No. 3: An arrangement that permits the removal of a glassware frame without the use of tools may be used if the frame will not fall out under conditions of intended use, including servicing, unless it is given a definite lifting-twisting or equivalent motion. The acceptability of the arrangement is to be determined with the fixture in its installed position. See 34.1.2 for marking requirements when the fixture can be mounted in more than one position.

Exception No. 4: A captive latch (a device that releases by at least two motions of the device, such as out and up) may be used in lieu of the combination of hinges and positive latch if spaced no more than 15 inches (381 mm) apart on the perimeter of the frame.

12.1.5 A frame or glass panel that is 300 square inches (1935 cm²) or less, and that must be opened for relamping, shall be provided with at least one hinge and a positive latch as defined in 12.1.4.

Exception No. 1: A spring catch that does not provide a positive latch may be used if it engages for a distance of 1/8 inch (3.2 mm) or more.

Exception No. 2: A framed-glass panel that is no more than 50 inches (1.27 m) long and no less than 3 inches (76.2 mm) wide may be removable from the fixture for relamping.

Exception No. 3: A glass panel with no dimension greater than 26 inches (660 mm) may be secured by one stud and nut or the equivalent.

Exception No. 4: A frame may be secured by two or more captive latches for glassware of 150 square inches (968 cm²) or less, or by four or more captive latches for glassware of 300 square inches or less.

12.2 Clips

12.2.1 A clip required to support flat glass shall comply with the requirements in 12.2.2 – 12.2.8.

12.2.2 The width and overlap of a clip shall be as indicated in Table 12.1.

Table 12.1
Clip dimensions

Exposed area of glass panel				Minimum clip size			
More than		No more than		Width		Overlap	
Inches ²	(cm ²)	Inches ²	(cm ²)	Inch	(mm)	Inch	(mm)
0	0	300	1935	3/32	2.4	3/16	4.8
300	1935	500	3226	1/4	6.4	1/4	6.4
500	3226	1100	7097	1/2	12.7	1/2	12.7

12.2.3 A clip may be mounted with either the width or the edge of the clip bearing against the glass.

12.2.4 There shall be one or more clips for each 8 inches (203 mm) of edge or fraction thereof, as determined by dividing the perimeter of the glassware in inches by 8. A double clip is counted as two clips.

12.2.5 The double clip mentioned in 12.2.4 is a clip having at least double the width required in Table 12.1 or is one having a pair of fingers, each of which has the width required in Table 12.1, in which case the single supporting member that is common to the two fingers shall have a width at least double that required in Table 12.1.

12.2.6 There shall be at least one clip on each straight edge that is more than 12 inches (305 mm) long.

12.2.7 The distance between the adjacent edges of any two clips, as measured along the edge of the glassware, shall be no more than 16 inches (406 mm).

12.2.8 A channel, trough, frame, or clip for holding a glass panel or lens shall be constructed of metal not less than 0.017 inch (0.43 mm) thick if of galvanized steel, 0.016 inch (0.41 mm) thick if of uncoated steel, and 0.020 inch (0.51 mm) thick if of aluminum or copper.

Exception: A clip that is used to restrain but not support glass may be of a polymeric material that complies with Polymeric Materials, Section 59.

12.2.9 An adhesive material used to secure glassware to a frame shall comply with the applicable requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, with respect to the type of materials to be joined.

12.2.10 A glass and frame assembly that complies with 12.2.9 shall be replaceable as a unit and shall be marked, as specified in 34.1.6, to indicate that the complete assembly should be replaced when glass is broken.

12.3 Shaped glass supports

12.3.1 A glass globe, molded or blown glass, a decorative glass part, or the like shall be mounted by means of:

- a) A circular fitter with at least three setscrews, thumbscrews, or the equivalent;
- b) A stud with threaded end and nut;
- c) Threads on glass part that engage a threaded fitter;
- d) Spring clips that hold only by means of friction, if the assembly complies with 30.1;
- e) Equivalent construction investigated and found to comply with 30.1;
- f) Adhesive that complies with 12.2.9 and 12.2.10.
- g) Its own weight in a frame that is not hinged or does not need to be removed for relamping.

CONSTRUCTION – ELECTRICAL

13 General

13.1 A fixture designed for use with a remotely mounted ballast shall be provided with leads for ballast secondary connections that extend from the lampholders to the point in the fixture where secondary connections will be made. The leads shall comply with the requirements of Wiring and Conductors, Section 18. The fixture shall comply with 20.4.

13.2 A wiring device (a switch, fuseholder, lampholder, or the like) shall be prevented from any turning, by a means specified in 7.2, that would apply tension to splices or other wiring connections, cause damage to the wiring, or otherwise adversely affect the assembly.

13.3 A fixture shall be constructed such that each lamp and automatic starter can be replaced without disturbing any supply wire and without subjecting any other wiring, component, or part to mechanical damage.

14 Device and Conductor Ratings

14.1 Voltage

14.1.1 Electrical devices and insulated conductors shall have a voltage rating at least equal to the voltage that will be applied to them during intended use.

14.1.2 A lampholder shall have a voltage rating no less than the output-voltage rating (if any) marked on the ballast with which it is used.

Exception: If the ballast is additionally marked with a secondary voltage to ground that is less than the marked output voltage, the rating of the lampholder may be no less than the marked secondary voltage to ground.

14.2 Current

14.2.1 Electrical devices shall have an ampere rating and insulated conductors shall have an ampacity rating for the total current, as specified in 14.2.2 and 14.2.3, to which they will be subjected during intended use.

14.2.2 The ampere rating of a device and the ampacity of a conductor shall be the combination of:

- a) The sum of the ampere ratings of all devices (transformer, ballast, relay, and the like) that use the conductor for their supply; and
- b) A value of 15 amperes for one or two single receptacles or for one duplex receptacle.

14.2.3 The ampacity rating of some commonly used insulated conductors are indicated in Table 14.1.

Table 14.1
Maximum ampacities of wires and cords with copper conductors

Types of wire and cord ^a	Ampacity				
	18 AWG	16 AWG	14 AWG	12 AWG	10 AWG
SI equivalent, mm ² sectional area	0.82	1.3	2.1	3.3	5.3
General Building Wires RH, RHH, RHW, RUH, RUW, T, THHN, THW, THWN, TW, XHHW	—	—	20	25	40
ALA, AL, Z	—	—	40	50	70
A, AA	—	—	45	55	75
PFAH, TFE	—	—	60	80	110
Fixture Wires RFH-1, RFH-2, FFH-1, FFH-2, TF, TFF, TFN, TFFN, AF, CF, HF, HFF, KF-1, KFF-1, KF-2, KFF-2, PAF, PAFF, PF, PFF, PGF, PGFF, PTF, PTFF, SF-1, SF-2, SFF-1, SFF-2, ZF, ZFF, XF, XFF	6	8	17	23	28
Flexible Cords S, SO, SOO, SJ, SJO, SJOO, ST, STOO, SJT, SJTO, SJTOO, STO, SP-1, SP-2, SPT-1, SPT-2, SV, SVO, SVOO, SVT, SVTO, SVTOO, SE, SJE, SPE-1, SPE-2	7(10) ^b	10(13) ^b	15(18) ^b	20(25) ^b	25(30) ^b
AFC, AFPD, CFPD	6	8	17	23	28
Appliance Wiring Material	6	8	17	23	28

^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.

^b These ampacities are applicable to 3-conductor cords and 4-conductor cords with three conductors carrying current. The corresponding ampacities for these sizes of 2-conductor cords and 3-conductor cords with two conductors carrying current are shown in parentheses.

14.2.4 The ampere rating of a switch shall be multiplied by the derating factor as indicated in Table 14.2 before consideration of its current handling capability for the specified load.

Table 14.2
Switch derating factors

Switching load	Switch type			
	AC general use ^a	AC "L" ^b	AC	DC
Transformer	none	none	1/2	—
Receptacle	none	none	1/6	1/10
Ballast	none	none	1/2	—
^a This column applies not only to general-use AC switches (for mounting in flush-device outlet boxes) but also to switches of the fixture, pendant, and through-cord types rated AC only. ^b A switch, other than a type mentioned in note a, that has been investigated for the control of inductive loads, is marked with the letter "L" in conjunction with the current rating at which the inductive rating applies; for example, "1 ampere, 125 volt, L".				

15 Switches

15.1 A fixture designed to operate on a branch circuit of more than 300 volts to ground shall not incorporate a manually operated switch.

15.2 A special-use snap switch shall be rated in accordance with Table 14.2.

15.3 A manually operated switch used in a fixture designed to operate on a circuit of more than 150 volts to ground shall be located so that it is not readily accessible, such as behind a lens or diffuser, a cover plate, or the equivalent.

15.4 A manually operated switch used in a ceiling-mounted fixture and located within 2 feet (0.61 m) of the ceiling shall be of the pull type. The distance from the switch to the ceiling includes the maximum length of flexible cord, stem, or chain provided with the fixture.

Exception: A switch that:

a) Does not energize or de-energize the fixture during intended use (such as a switch that regulates light level); or

b) Is located so that it is not readily accessible;

need not be of the pull type.

15.5 A switch used in a 2-wire input circuit derived from a branch circuit of between 125 and 250 volts shall be of the double-pole type.

Exception: If the fixture is marked as specified in 34.1.7, a single-pole photocontrol switch may be used.

15.6 A switch used in a multiwire circuit shall be of the multipole type, and shall be connected such that all ungrounded wires are switched.

15.7 A switch shall not be connected in the secondary of a ballast unless it is rated for switching a fluorescent lamp load.

15.8 A fixture intended for use with a plug-in type photocontrol shall employ a receptacle that complies with the Standard for Plug-In, Locking Type Photocontrols for Use with Area Lighting, UL 773.

15.9 A fixture provided with a receptacle for a photocontrol shall be shipped with the control or with a shorting or open-circuit plug.

16 Convenience Receptacles and Fuses

16.1 A convenience receptacle may be provided only in a wall, under-cabinet, or floor-mounted fixture. See 34.1.2 for possible marking requirements.

16.2 No more than one duplex or two single convenience receptacles may be provided with each fixture.

16.3 A convenience receptacle shall be of the grounding type.

Exception: A 2-pole, 2-wire, parallel blade, polarized, nongrounding-type receptacle may be provided if the fixture is marked in accordance with 34.2.3 to indicate that the fixture is intended for replacement use.

16.4 The face of a convenience receptacle that is less than 5/8 inch (15.9 mm) wide or 7/8 inch (22.2 mm) long shall project a minimum of 0.015 inch (0.38 mm) and a maximum of 3/16 inch (4.8 mm) from any part of the receptacle-mounting surface, including screwheads, and the like, which is within a rectangle 5/8 inch wide and 7/8 inch long that is located symmetrically about the receptacle contacts.

Exception: The minimum projection may be 3/32 inch (2.4 mm) if the mounting surface for the receptacle is electrically conductive.

16.5 A fuse, if provided, shall be mounted in a fuseholder of the correct type and rating.

17 Lampholders

17.1 A ballast that is marked for use with circuit interrupting lampholders shall be connected to single pin circuit interrupting lampholders, bi-pin circuit interrupting lampholders, or recessed double contact lampholders. Recessed double contact lampholders for use with 800 and 1500 milliampere rapid start lamps are not of the circuit interrupting type.

17.2 A fixture requiring a circuit interrupting lampholder in accordance with 17.1 shall have it located in the low voltage end of the ballast circuit. The lampholder at the high voltage end shall be rated 600 volts or more.

Exception: A lampholder rated at 250 volts may be employed at the high voltage end if supplementary insulation consisting of 1/64-inch (0.4-mm) thick fiber or phenolic composition or a permanent air spacing of no less than 5/64 inch (2.0 mm) is provided between the back of the lampholder and the metal of the fixture.

17.3 A fixture shall not use lampholders designed for ferrule-type lamps.

17.4 A lamp-supported lampholder shall be provided with stranded wiring.

18 Wiring and Conductors

18.1 General

18.1.1 A conductor shall be made of copper or copper alloy.

18.1.2 A conductor shall have insulation rated for the voltage, temperature, and condition of service to which it will be subjected under conditions of intended use.

18.1.3 A conductor shall be no smaller than No. 18 AWG (0.82 mm²).

18.1.4 Some commonly used types of wire and flexible cord, and types of appliance wiring material that are acceptable if enclosed in accordance with 8.1, are shown in Tables 18.1 and 18.2.

18.1.5 A fixture shall use wiring rated for at least the temperature indicated in Table 18.3.

Exception: If the results of the Temperature Test in Section 28 show that wiring rated for a lower temperature is acceptable, wiring rated for that temperature may be used.

18.1.6 A means shall be provided to hold all wiring, including all through branch-circuit conductors, effectively in place within the wireway if the fixture enclosure must be opened to replace lamps or starters.

18.1.7 A reusable plastic wire-tie, a fiber strip, a smooth metal strip, or the like, is acceptable for holding wiring in place as required in 18.1.6, but an adhesive tape wrap or twist tie that consists of wires with or without a nonmetallic protective ribbon is not acceptable.

18.2 Flexing of wires

18.2.1 A wire or cord that may be flexed because of an adjustable, movable, or flexible part of a fixture shall be of the stranded type and shall be secured so that it will not be cut or abraded under conditions of intended use, including relamping, servicing, and inspection of the supply connections.

18.2.2 A wire or splice shall be located so that it need not be disturbed when a lamp or starter is being replaced.

Exception: Flexible wiring to a lampholder for circular lamps need not be so located.

18.3 Splices and connections

18.3.1 A splice shall be made mechanically and electrically secure and, unless an acceptable wire connector is used, shall be soldered.

18.3.2 A splice shall be inaccessible when a lamp or starter is being replaced.

18.3.3 A soldered splice and a splice made with an uninsulated wire connector shall be covered with insulation equivalent to that required on the conductors. The equivalence is to be with respect to the voltage and the temperature ratings as specified in Table 18.2, and to the thickness.

Table 18.1
Temperature and voltage ratings of wire and cord

Temperature rating		300 Volts	600 Volts	1000 Volts
60°C (140°F)	Wire	—	MTW, RUW, T ^a , TF, TFF, TW	—
	Cord	C ^a , PD ^a , SJE, SJO, SJOO, SJO, SJTO, SJTOO, SP-1, SP-2, SPE-1, SPE-2, SPT-1, SPT-2, SV, SVE, SVO, SVOO, SVT, SVTO, SVTOO	S, SE, SO, SOO, ST, STO, STOO	—
75°C (167°F)	Wire	FFH-1, RFH-1	FEPW ^a , FFH-2, RFH-2, RH ^a , RHW, RUH ^a , THW, THWN, XHHW, ZW	RH-10
	Cord ^b	SJ ^b , SJE ^b , SJO ^b , SJOO ^b , SJO ^b , SJTO ^b , SVO, SVOO, SVT, SVTO, SPE-1, SPE-2, SPT-1, SPT-2	S ^b , SE ^b , SO ^b , SOO, ST ^b , STO, STOO, THWN	—
90°C (194°F)	Wire ^c	CF ^a	FEPW ^a , RHH ^a , TFFN, TFH, THHN ^a , XHHW ^a , Z, ZW ^a	THW
	Cord ^c	CFPD ^a , HPN, SJO ^b , SJOO ^b , SJO ^b , SJTO ^b , SPE-1, SPE-2 ^b , SPT-1 ^b , SPT-2 ^b , SVO ^b , SVOO ^b , SVT ^b , SVTO ^b	SO ^b , SOO ^b , ST ^b , STOO ^b	—
105°C (221°F)	Wire	—	—	—
	Cord ^{b,c}	SJO ^b , SPE-1 ^b , SPE-2 ^b , SPT-1 ^b , SPT-2 ^b , SVT ^b	ST ^b	—
125°C (257°F)	Wire ^c	AI ^a	AI ^a	—
	Cord	—	—	—
150°C (302°F)	Wire	AF ^a , SFF-1, XF, XFF	HF, HFF, PAFF, PFF, PGFF, PTFF, SFF-2, ZF, ZFF	—
	Cord	—	—	—
200°C (392°F)	Wire	A ^a , AA ^a , KF-1, KFF-1, SF-1	KF-2, KFF-2, PF, PGF, SF-2	—
250°C (482°F)	Wire	—	PAF, PFAH ^a , PTF, TFE ^a	—
	Cord	—	—	—

^a Not acceptable for use in fixtures intended to be used in damp or wet locations in accordance with Sections 62 – 70.

^b Only if surface marked "75°C", "90°C", or "105°C" whichever is applicable.

^c See 18.1.5 for increased temperature ratings permitted by use of sleeving.

Table 18.2
Appliance wiring material insulation type, voltage,
and temperature ratings^a

Types of Insulation	Minimum thickness of insulation in inches (mm)					
	300 Volts			600 Volts		
	Without braid	With added impregnated braid cover		Without braid	With added impregnated braid or nylon cover [min 0.004 inch (0.1 mm)]	
Thermoplastic	0.013 (0.33)	0.013	(0.33)	0.027 (0.69)	0.015	(0.38)
Thermoset	0.013 (0.33)	0.013	(0.33)	0.027 (0.69)	0.027	(0.69)
Rubber	0.027 (0.69)	0.013	(0.33)	0.040 (1.02)	0.027	(0.69)
Neoprene	0.027 (0.69)	0.013	(0.33)	0.042 (1.07)	0.027	(0.69)
Silicone Rubber	0.027 (0.69)	0.013	(0.33)	0.040 (1.02)	0.027	(0.69)
Fluoroplastic ^b	0.012 (0.30)	—	—	0.018 (0.46)	—	—

^a The temperature marking of appliance-wiring material or miscellaneous wire consists of:

- 1) Colored threads;
- 2) Durable, continuous (unbroken), straight, longitudinal stripes printed in indelible ink on the surface of the insulation; or
- 3) Durable and legible indelible ink printing (or legible indent printing) in words in degrees Celsius on (or in) the surface of the insulation.

The number and color of the threads or stripes are: one green for 75°C (167°F); one red for 90°C (194°F); one yellow for 105°C (221°F); one blue for 125°C (257°F); one brown for 150°C (302°F); one black for 200°C (392°F); two black for 250°C (480°F). If a stripe or thread is used to identify the temperature marking of an 80°C (176°F) thermoplastic-insulated wire (the identification is not required), the stripe or thread is green.

^b Polytetrafluoroethylene or fluorinated ethylene propylene.

Table 18.3
Required temperature rating of wire

Position of wiring ^a	Temperature	
	°C	°F
Permanently spaced no less than 3 inches (76.2 mm) from any ballast.	60	140
Less than 3 inches from, but not in contact with, any ballast except at the point of entry to the ballast	80 ^b	176 ^b
In contact with any ballast	90 ^b	194 ^b

^a The permanently attached leads provided as a part of ballasts and fluorescent lampholders are rated for a temperature of at least 90°C (194°F). If provided with an outer braid, the braid must be retained, as the wires are rated for 75°C (167°F) without it.

^b Wiring rated for a temperature of 75°C (167°F) or more may be used if it is provided with an outer braid.

18.3.4 General use insulating tape used in compliance with 18.3.3 is rated 80°C (170°F).

18.3.5 A wire connector, if supplied with the fixture for connection of field wires to the fixture, shall be rated for the size of wires to be connected.

18.3.6 An insulated wire connector shall be rated for the temperature and voltage involved.

Exception: A connector rated 300 volts may be used to join wires having a potential of more than 300 volts if the splice (including the connector) is additionally covered with insulation acceptable for the voltage difference between the higher voltage and 300 volts.

18.3.7 If stranded internal wiring is connected to a wire-binding screw or stud terminal, the construction shall be such that no loose strands result. This shall be accomplished by one of the following means:

- a) The use of a pressure terminal connector, soldering lug, or crimped eyelet;
- b) By soldering all strands of the wire together;
- c) By tightly twisting all strands together;
- d) By an equivalent means.

18.4 Prevention of wire damage

18.4.1 A fixture shall be constructed so that a wire can be pulled through, or the fixture otherwise wired, without damaging the covering or insulation on the conductors. A wire enclosure shall be free from burrs, fins, and other sharp edges that can contact wiring.

18.4.2 Threads of a sheet metal or a self-tapping screw shall not be exposed in a wiring enclosure for a distance of more than 3/16 inch (4.8 mm).

Exception: If the wiring is held or positioned away from such screw threads, the threads may be exposed.

18.4.3 If a conductor passes through an opening or crosses over the edge of sheet-metal it shall be held away from the edge of the metal or shall be protected by a bushing or a grommet or by rolling the edge of the metal no less than 120 degrees. Sleeving is not an acceptable means of preventing cutting and abrasion of wires.

Exception: The edges of sheet metal thicker than 0.042 inch (1.07 mm) need only be treated by reaming or the equivalent to remove burrs, fins, and sharp edges.

18.4.4 A bushing used to comply with 18.4.3 shall be held in place, and a bushing constructed of insulating material shall be at least 3/64 inch (1.2 mm) thick. A rubber bushing is not acceptable.

Exception: A bushing less than 3/64 inch thick is acceptable if an investigation shows that the mechanical properties contemplated are provided.

18.5 Wiring to a lamp-supported lampholder

18.5.1 Wiring to a lamp-supported lampholder shall comply with the accessibility requirements in Accessibility of Current-Carrying Parts, Section 22, and the strain relief test requirements in 26.1 and 26.2.

Exception: A construction is considered to have acceptable strain relief provision and need not be subjected to the strain relief test if the lampholder leads are connected inside the ballast with no intervening splice between the lampholder and the ballast.

19 Polarity

19.1 If a fixture rated at a nominal 118 volts employs a single-pole switch, or if the fixture employs a ballast that has a grounded (neutral) line lead or that is marked to indicate that one of its line leads is to be connected to the grounded (neutral) conductor of the power-supply circuit, one of the leads or terminals for connection to the branch-circuit supply wires shall be white in color and shall be connected to the white (or otherwise marked) conductor of the ballast.

20 Ballasts

20.1 A fixture shall employ Class P ballast(s) (including dimming types).

Exception No. 1: A fixture provided with straight tubular lamps may employ simple reactance ballasts which are not rated Class P.

Exception No. 2: A fixture that is intended to be installed outdoors only, complies with Part 4, and is marked in accordance with 35.3 may employ simple reactance ballasts which are not rated Class P.

20.2 A fixture shall be provided with a ballast designed for the operation of lamps of the size intended for use with the fixture and shall be wired in accordance with the diagram or instructions on or with the ballast.

20.3 A fixture that employs a ballast of the dimming type, or a simple reactance type ballast with more than one lead in and one lead out, shall be investigated to determine its acceptability.

20.4 A fixture designed for a remotely mounted ballast:

- a) Shall be marked in accordance with 35.1;
- b) Shall be provided with means for connection of one of the supply wiring systems described in Power Supply Connection, Section 24; and
- c) Shall employ other than single-pin type lampholders.

21 Electrical Spacings

21.1 An electrical spacing shall be no less than those indicated in Table 21.1, and for supply wiring terminals no less than indicated in 21.2.

Exception No. 1: Spacings may be less than specified in Table 21.1 or 21.2 within a snap switch, lampholder, ballast, and similar component device that complies with the requirements for the device.

Exception No. 2: Spacings may be less than specified in Table 21.1 or 21.2 between uninsulated live parts of such a device and dead metal that is part of the device (including mounting screws, rivets, yoke, clamp, and the like).

Exception No. 3: Spacings may be less than specified in Table 21.1 or 21.2 between live parts and that part of a dead metal surface on which the device is mounted in the intended manner.

Table 21.1
Spacings

Spacings Involved			Minimum spacings									
			0 – 50 V (0 – 71 V) ^a		51 – 150 V (72 – 212) ^a		151 – 300 V (213 – 423) ^a		301 – 600 V (424 – 846 V) ^a		over 600 V (over 846 V) ^a	
			Inch	(mm)	Inch	(mm)	Inch	(mm)	Inch	(mm)	Inch	(mm)
Between uninsulated live parts and	Uninsulated live parts of opposite polarity	Through air	1/16	(1.6)	1/8	(3.2)	1/4	(6.4)	3/8	(9.5)	3/8	(9.5)
		Over surface	1/16	(1.6)	1/4	(6.4)	3/8	(9.5)	1/2	(12.7)	1/2	(12.7)
	Uninsulated grounded dead metal parts	Through air	1/16	(1.6)	1/4	(3.2)	1/4	(6.4)	3/8	(9.5)	1/2	(12.7)
		Over surface	1/16	(1.6)	1/4	(6.4)	3/8	(9.5)	1/2	(12.7)	5/8	(15.9)

^a The figures in parentheses are peak voltages. When evaluating the voltage of a circuit that produces other than an essentially sinusoidal waveform, both rms and peak values are considered and the requirement for the larger spacing is to be applied

21.2 The spacing between supply wiring terminals of opposite polarity and between the terminals 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, or as indicated in Table 21.1, whichever is higher.

21.3 The spacing between uninsulated live parts of different circuits involving different voltages shall be no less than that required for the circuit of the higher voltage.

21.4 Each spacing at a fuse or a fuseholder is to be measured with the fuse in place. The fuse is to have maximum standard dimensions.

21.5 Each spacing at a supply wiring terminal is to be measured with wire of the correct size for the rating connected to the terminal during intended service, but with wire no smaller than No. 14 AWG (2.1 mm²).

21.6 When evaluating a spacing, any wire or cord not in compliance with the insulation thickness requirements in 18.1.2, 18.1.4, and 22.3.1 (including enamel-insulated wire) is considered to be a bare, current-carrying part.

21.7 If provision for the connection of conduit or armored cable is provided, the spacing shall be measured with the fitting in place, whether it is furnished with the fixture or not.

21.8 A spade or ring wire connector shall be prevented from turning by a shoulder, boss, or an equivalent means, if such turning could reduce the spacing to a value less than required. A lock washer alone is not acceptable for this purpose.

Exception: If a wiring lug or connector can be turned ± 30 degrees from normal without reducing spacing as noted in Table 21.1 or 21.2, a restraint is not required.

22 Accessibility of Current-Carrying Parts

22.1 Accessibility determination

22.1.1 Current-carrying parts, insulated and uninsulated, that are determined to be accessible including during normal maintenance shall comply with the requirements in this section. Current-carrying parts are considered accessible if they can be contacted by the articulate probe that is illustrated in Figure 22.1. The probe may be positioned as specified in 22.1.2.

Exception: The probe illustrated in Figure 22.2 may be used if:

- a) All or part of an enclosure must be removed to perform normal maintenance, including relamping; and
- b) The fixture is rated for 277V or higher or is marked "Not for Residential Use" in accordance with 34.3.4.

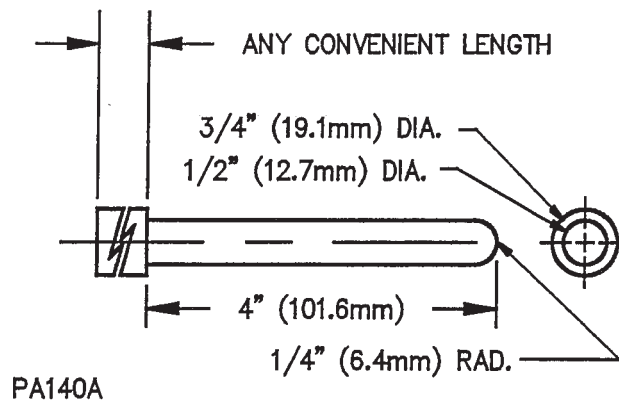
22.1.2 With respect to the requirement in 22.1.1, the probe may be articulated into any configuration, and may be rotated or angled to any position, before, during, or after inserting into the opening, and the penetration may be to any depth allowed by the opening size, including a minimum depth combined with the maximum articulation.

22.2 Uninsulated parts

22.2.1 The following uninsulated current-carrying parts may be accessible. Contact with all other uninsulated current-carrying parts shall be prevented by an accessibility barrier as specified in 22.4.1 – 22.4.3.

- a) The uninsulated current-carrying contacts of a lampholder or automatic starter holder to which a lamp or automatic starter connects.
- b) An uninsulated current-carrying part that involves a voltage of less than 30 volts RMS (42.4 volts peak) and is electrically isolated from the primary circuit.

Figure 22.2
Straight probe



22.3 Insulated parts

22.3.1 The following insulated current-carrying parts may be accessible. Contact with all other insulated current-carrying parts shall be prevented by an accessibility barrier as specified 22.4.1 – 22.4.3.

- a) Appliance wiring material that complies with the insulation requirements specified in Figure 22.3 and is routed through the chain of a chain-pendant fixture.
- b) Any flexible cord specified in Table 18.1 if it is type SP2, SPT2, or heavier cord.
- c) Any wire specified in Table 18.1 or any 600 volt rated appliance wiring material specified in Table 18.2 that:

- 1) Does not terminate in a lamp-supported lampholder and;
- 2) Is:
 - i) Visible for the entire length that is accessible;
 - ii) Routed in close proximity to a structural part of the fixture;

Exception: Wiring to an adjustable spotlight or similar construction need not be routed in close proximity to a structural part of the fixture.

- iii) Secured at least every 3 inches (76.2 mm) if stranded wire or every 4 inches (101.6 mm) if solid wire to a structural part of the fixture or threaded through chain links; and

Exception: Wiring to an adjustable spotlight or similar construction need not be secured where flexing of the wire is required for adjusting of the light.

3) Either:

- i) Is accessible for no more than four inches and contains no splices; or
- ii) The wire is enclosed in a minimum 0.01 inch (0.25 mm) thick glass fiber or thermoplastic sleeving and factory-made splices using insulated crimp type connectors are enclosed in a minimum 0.01 inch (0.25 mm) thick glass fiber or thermoplastic sleeving.

d) Any wire specified in Table 18.1 or any 600 volt rated thermoplastic insulated appliance wiring material specified in Table 18.2 that:

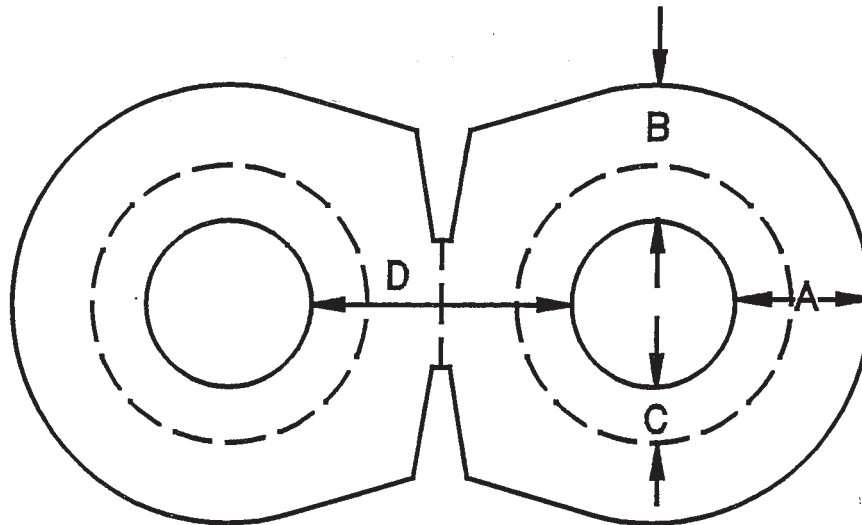
- 1) Terminates in a lamp-supported lampholder and;
- 2) Has a minimum 0.027 inch (0.69 mm) thick insulation and;
- 3) Is covered – collectively if more than one wire – with nominal 0.020 inch (0.51 mm) thick glass fiber or thermoplastic sleeving that extends to within 1/2 inch (12.7 mm) of the lampholder from a point within the enclosure and;
- 4) Has no splices between the ballast and the lampholder.

e) The integral enclosure of a transformer or any other component device that complies with 22.4.1 – 22.4.3.

22.3.2 The following insulated current-carrying parts may be accessible to incidental contact only during user maintenance, including lamp and starter replacement:

- a) The terminals of a ballast, capacitor, or terminal block and the ballast coil, if insulated with materials that are mechanically secured in place and comply with 22.4.1.
- b) Factory made splices employing insulated crimp-on wire connectors or wire connectors (other than the twist-on type) that comply with the Standard for Splicing Wire Connectors, UL 486C, as long as they do not have to be moved to accomplish the maintenance operation.
- c) Any wiring, as long as it does not have to be moved to accomplish the maintenance operation.

Figure 22.3
Minimum insulation thickness for non-enclosed appliance wiring
material in the chain of a chain-pendant fixture



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A – Minimum acceptable average thickness away from tear area and outside point – 0.040 inch (1.02 mm).

B – Minimum acceptable thickness at any point (before separation*) – 0.035 inch (0.89 mm).

C – Minimum acceptable thickness at any point after separation* – 0.019 inch (0.49 mm).

D – Minimum acceptable distance between copper conductors* – 0.060 inch (1.52 mm).

*Not applicable for individual conductors.

22.4 Accessibility barriers

22.4.1 The accessibility barrier, as referenced in 22.2.1 and 22.3.1, shall be constructed of:

- a) Metal (ferrous, aluminum, brass, zinc, or copper) minimum 0.016 inch (0.41 mm) thick;
- b) Glass, porcelain, or ceramic minimum 1/8 inch (3.2 mm) thick;
- c) Impregnated glass fiber sleeving at least 0.01 inch (0.25 mm) thick that is rated for the temperature involved;
- d) Vulcanized fiber minimum 0.028 inch (0.71 mm) thick; or
- e) A polymeric material that complies with 22.4.2.

Exception: An accessibility barrier may be of a thickness less than that specified if it complies with the requirement in 22.4.3.

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

- a) Be rated for at least the maximum operating temperature of the barrier in the fixture;
- b) Be classified at least 94HB in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94; and
- c) Comply with minimum property and test requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C. The minimum properties are 30 seconds ignition time (maximum assigned performance level category 3) for hot wire ignition (HWI) and 60 arcs (maximum assigned performance level category 1) for high-ampere arc ignition (HA). The test requirement is the mold stress relief test referenced in 59.8 of this standard.

22.4.3 The accessibility barrier as referenced in 22.2.1 and 22.3.1 need not be of the minimum thickness specified in 22.4.1 if the application of a force of 10 pounds (44.5 N) over an area of 1 square inch (6.45 cm²) on the barrier does not result in:

- a) Permanent distortion of a metal barrier;
- b) Temporary displacement of a metal barrier that results in a reduction in spacings; or
- c) Breaking or cracking of a glass, porcelain, ceramic, or polymeric barrier.

Permanent or temporary distortion of a polymeric barrier is acceptable if parts required to be inaccessible continue to be inaccessible as specified in 22.2.1 and 22.3.1 both during and after the application of the force.

23 Grounding

23.1 General

23.1.1 A fixture having a metal part not intended to be electrically live that is accessible using the probe illustrated in Figure 22.1 and that could be inadvertently energized, shall be provided with a means for connection to the branch circuit ground in accordance with 23.1.3 – 23.1.12. A means for grounding not described in 23.1.3 – 23.1.12 shall be investigated in accordance with the Standard for Electrical Grounding and Bonding Equipment, UL 467.

Exception: If the only metal parts of the fixture are the chain links, a grounding means need not be provided.

23.1.2 An equipment grounding means shall be provided on the cross-bar (mounting strap), if the cross-bar and the fixture are conductively connected after installation. Otherwise, the equipment grounding means shall be provided on the fixture.

Exception: A grounding means need not be provided on a post-mounted fixture if it is shipped with, or marked for use with, fixture fittings (a post as specified in Fixture Fittings; Section 47 or a post arm) that are conductively connected to the fixture. See 34.2.4.

23.1.3 A means to connect the equipment grounding conductor of the branch circuit to the fixture as noted in 23.1.2 shall be provided. This shall consist of a pigtail lead, a pressure terminal connector, a wire binding screw, the grounding contact of a receptacle or the grounding pin of an attachment plug or the equivalent. The grounding means shall be at the same location as the power supply connection means.

23.1.4 A fixture equipment grounding conductor shall not be smaller than the gauge of wire used for the fixture's supply connections nor smaller than No. 18 AWG (0.82 mm²). If insulated, this conductor, where visible to the installer, shall have a braid of continuous green color with or without a yellow tracer or, if no braid is employed, the insulation on the conductor shall be green with or without one or more yellow stripes. A conductor having green insulation and a braid of other than green may be employed if the green insulation is readily visible where connection to the branch-circuit supply wires will be made.

23.1.5 A fastener (screw, rivet or other device) used to terminate the fixture equipment grounding conductor shall not also be used to fasten another component part, including a bonding conductor.

Exception No. 1: The equipment grounding conductor of a chain pendant fixture may be secured to a ring terminal that is, in turn, secured to a threaded nipple and a screw collar loop.

Exception No. 2: A grounding conductor may be secured to the same screw as the bonding conductor if the grounding conductor is separately secured such that it need not be loosened or removed during replacement or disconnection of any bonding conductor.

23.1.6 The reliability of the grounding system shall be maintained as follows:

- a) Positive means of maintaining contact between conductive surfaces are required, e.g. screws, rivets, welding, etc.
- b) If the reliability of a grounding connection is questioned it shall be subjected to the test in Grounding Continuity Test, Section 29.
- c) Thermoplastic materials used in a grounding system shall comply with Polymeric Materials, Section 59.

23.1.7 The cord of a cord-connected fixture shall contain an equipment grounding conductor complying with 23.1.4 and 23.1.5.

Exception: A pendant-type fixture construction in which a 2-wire cord and separate equipment grounding conductor are intended to be interwoven though the chain need not comply with 23.1.5.

23.1.8 A pressure-type grounding terminal for field connection shall comply with the requirements in the Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors, UL 486E.

23.1.9 A wire binding screw intended for field connection of the branch circuit equipment grounding conductor shall comply with the following:

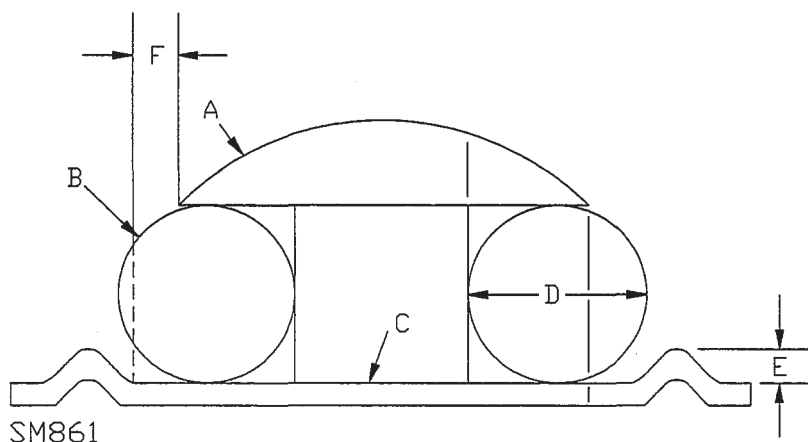
- a) The screw shall be No. 8 (4.2 mm major diameter) or larger.
- b) The screw head shall be colored green and have a hexagonal shape, slotted, or both.
- c) The screw shall not be used to secure more than one wire except as permitted by Exception No. 2 to 23.1.5.
- d) A sheet metal screw shall not be used.

23.1.10 A cupped washer shall be provided to hold the wire under the head of the screw.

Exception No. 1: A cupped washer need not be provided if there are two raised areas around the tapped hole that are minimum 1/4 inch (6.4 mm) apart (on center) and comply with Figure 23.1.

Exception No. 2: Other means may be used to hold the wire if investigated and found to be equivalent.

Figure 23.1
Terminal-conductor relationship



A – Wire binding Screw

B – Conductor

C – Terminal Plate

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

E – Minimum height of raised areas = 0.04 inch (1.0 mm)

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

23.1.11 A pressure terminal intended for field connection of an equipment grounding conductor shall be plainly identified by being marked in accordance with 34.2.2.

23.1.12 A terminal plate having a tapped hole for a wire binding screw shall be of metal and shall have no fewer than two full threads in the metal. A detail, such as an extruded hole, may be used to provide two full threads.

23.2 Bonding

23.2.1 All conductive parts of a fixture not intended to be electrically live that are accessible using the probe illustrated in Figure 22.1 and that could inadvertently become energized shall be conductively bonded to the fixture grounding means. Any part with a non-conductive coating may require treatment of the part, such as masking, removal of the coating at points of connection, or the use of fastening means that penetrate the surface coating. If special treatment is necessary or if grounding continuity is not obvious, the resistance shall be measured by the method described in Grounding Continuity Test, Section 29.

Exception: Chain links need not be conductively bonded.

23.2.2 If the integrity of the bonding system relies on the thickness and insulation characteristics of a polymeric material, the material shall comply with Polymeric Materials, Section 59.

23.2.3 A ballast, transformer, or similar device shall be mounted in contact with the metal of the fixture so as to provide grounding continuity.

23.2.4 A grounding-type convenience receptacle mounted in a metal fixture enclosure shall have the receptacle grounding terminal bonded to the fixture grounding system by one of the following methods:

- a) Riveting, bolting, or welding the metal mounting yoke or strap (if provided) of the receptacle to the metal fixture enclosure.
- b) A copper bonding wire equal to or greater than the supply leads to the receptacle and connected to the fixture enclosure in a manner that complies with the 23.2.6.

23.2.5 A part that:

- a) Is required to be grounded;
- b) Is likely to be removed during normal use, including relamping; and
- c) Supports a current carrying component;

shall be bonded to the fixture. A wire used to bond the part shall be stranded copper the same wire gauge as the current carrying conductors to that part, or larger.

Exception: A part provided with a disconnect that includes a bonding wire and, simultaneously makes and breaks all conductors or interrupts the bonding lead last and connects it first, is not required to have a separate wire to bond the part.

23.2.6 A bonding wire shall be connected by:

- a) A machine screw and nut;
- b) A machine screw threaded into metal thick enough to permit at least two full threads;
- c) A sheet metal or self-threading screw that withstands a torque of 30 inch-pounds without stripping;
- d) A rivet; or
- e) A means found equivalent by investigation.

23.2.7 All parts required to be grounded shall be conductively bonded to the ground termination point such that the resistance between any two points is 0.1 ohm or less as determined in 29.2.

24 Power Supply Connection

24.1 Supply connection systems

24.1.1 A fixture shall be constructed so that it can be connected to a branch circuit wiring system by at least one of the following:

- a) Provision on the fixture for mounting over an outlet box as described in General, Section 36. (For a suspended fixture, the provision is usually a canopy.)
- b) Provision for connection of conduit as specified in 24.2.1 – 24.2.5.
- c) A length of flexible cord as specified in Construction – Electrical, Section 38.
- d) A length of flexible conduit with emerging leads, or leads only, but with provision for attachment of conduit where leads emerge as specified in Construction – Mechanical, Section 37.
- e) For a fixture intended for use in a suspended, T-bar grid ceiling only, or a recessed fixture, provision for a proprietary wiring system, such as a prefabricated power and lighting distribution system in which fixtures are connected to the branch circuit by cable sets, or the like.
- f) Provision for mounting to a post as specified in General, Section 36.
- g) For a fixture with an integral post or pole, such as a bollard fixture, provision for mounting to a noncombustible base over a conduit stub and having internal supply conductors reaching within 6 inches (152 mm) of the base.

24.1.2 A fixture shall have provision for connection to a single branch circuit of 20 amperes. This does not preclude connection to multiple inputs (usually switched) that derive from a single branch circuit.

Exception: A fixture with a dimming ballast may be connected to more than one 20 ampere branch circuit.

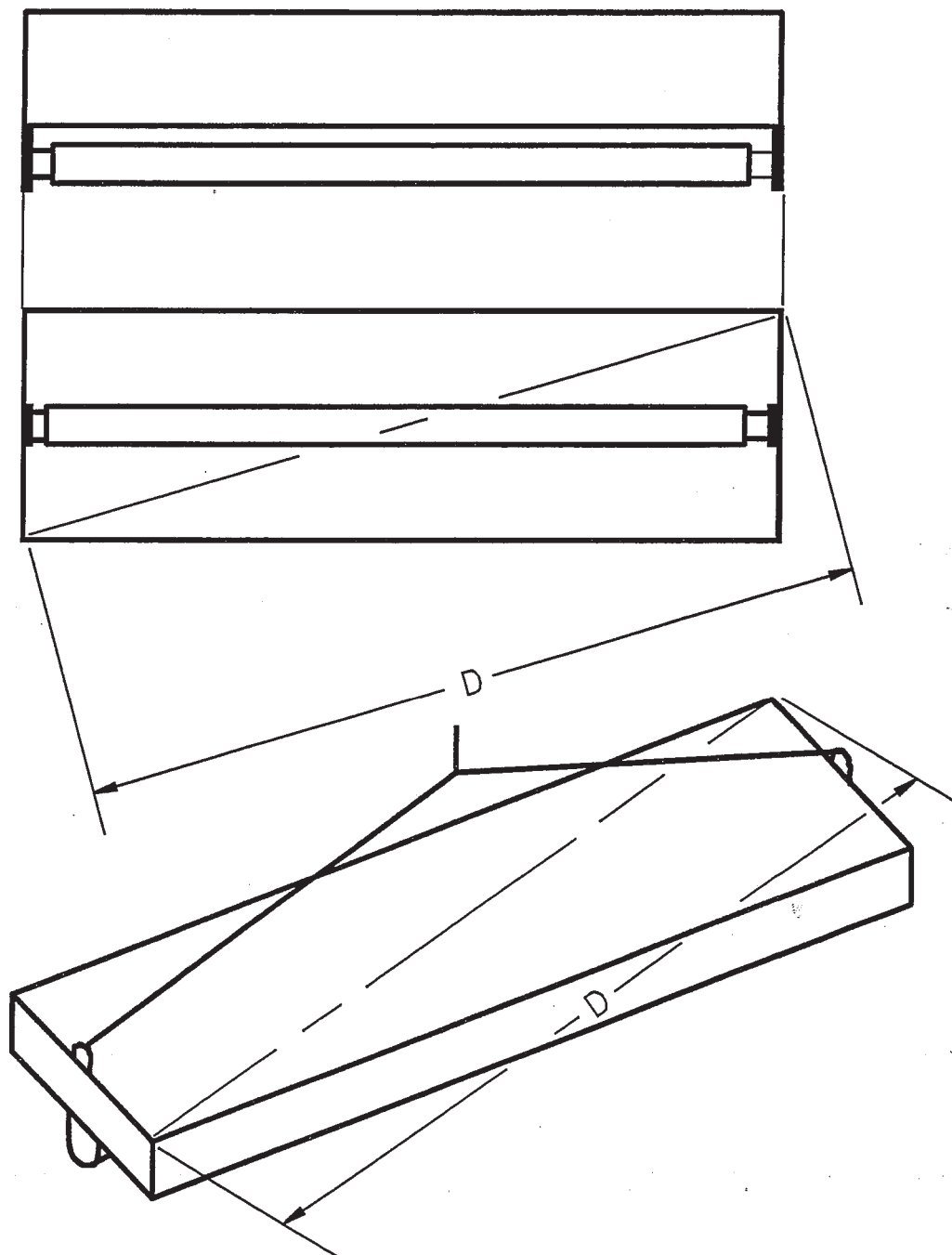
24.1.3 The provision for connection to the supply source shall permit the connections to be made at a common point without the addition of wiring in the field.

Exception: If an open hole is provided, wiring shall be provided to that hole.

24.1.4 A connection between the fixture conductor or terminal and the conductor of the power supply branch circuit shall be readily accessible for inspection. The connections are considered readily accessible if the weight of the fixture does not exceed 25 pounds (11.35 kg), and the weight-dimension value, defined as the value obtained by multiplying the weight in pounds (kg) by the maximum length or diameter in inches (mm), does not exceed 500 (5761). A fixture with a weight greater than 25 pounds or a weight-dimension value greater than 500 shall be provided with a means of access to the supply wiring splices without removing the fixture.

24.1.5 The maximum length or diameter (D in Figure 24.1) used in making the weight-dimension value determination specified in 24.1.4 is to be measured in a horizontal plane with the fixture oriented in the intended position after installation, as illustrated in Figure 24.1. The maximum length is the maximum diameter or diagonal along the horizontal plane in any direction.

Figure 24.1
Maximum length of fixture



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D — Maximum horizontal diameter or diagonal