UL 234

STANDARD FOR SAFETY

Low Voltage Lighting Fixtures for Use in Recreational Vehicles

UL Standard for Safety for Low Voltage Lighting Fixtures for Use in Recreational Vehicles, UL 234

Fifth Edition, Dated January 21, 2005

Summary of Topics

This revision to ANSI/UL 234 dated June 10, 2020 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

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

The requirements are substantially in accordance with Proposal(s) on this subject dated March 13, 2020.

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UL 234

Standard for Low Voltage Lighting Fixtures for Use in Recreational Vehicles

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 – November, 1979
Second Edition – April, 1983
Third Edition – January, 1993
Fourth Edition – January, 1994

Fifth Edition

January 21, 2005

This ANSI/UL Standard for Safety consists of the Fifth Edition including revisions through June 10, 2020.

The most recent designation of ANSI/UL 234 as a Reaffirmed American National Standard (ANS) occurred on June 10, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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

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PART 1 – ALL LUMINAIRES

INTRODUCTION

1 Scope

1.1 These requirements apply to low-voltage luminaires, rated 24 volts or less, of the surface mounted or recessed type intended for permanent installation in park trailers in accordance with Article 552 of the National Electrical Code, NFPA 70, or in recreational vehicles in accordance with the Standard for Low Voltage Systems in Conversion and Recreational Vehicles, ANSI/RVIA LV (as referenced by Article 551 of NFPA 70).

1.2 These requirements do not apply to running or clearance lights intended to be mounted on the exterior of a recreational vehicle.

1.3 Light emitting diode (LED) components and subassemblies integral to a low voltage luminaire covered by this standard shall comply with the applicable requirements of the Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products, UL 8750.

2 Undated References

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

3 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. See Appendix for a list of standards covering components generally used in the products covered by this standard.

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.

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

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.

4 Units of Measurement

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

CONSTRUCTION

5 Frame and Enclosure

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

5.2 Sheet metal of a frame or enclosure shall be formed from stock having a minimum thickness of 0.016 inch (0.41 mm) if of steel and 0.020 inch (0.51 mm) if of aluminum.

Exception: Metal may be thinner if the part is investigated and determined to have equivalent mechanical strength. Among the factors to be considered are size, shape, function, and resistance to distortion both during intended use and service and anticipated abuse.

5.3 An enclosure or frame formed of a nonmetallic material may be used if, upon investigation, the material exhibits properties in accordance with the requirement in 5.1. Among the factors to be considered are:

a) Mechanical strength – the impact evaluation in Section 37, Impact Test;

b) Combustibility – minimum flammability rating of HB;

c) Mold stress – the mold stress evaluation in the Standard for Polymeric Material – Use in Electrical Equipment Evaluations, UL 746C shall be performed by the air oven method and;

d) Temperature – the material shall possess a mechanical impact Relative Temperature Index (RTI), in accordance with Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, of at least the temperature measured on the part during the normal temperature test.

Exception No. 1: If the temperature measured during the normal temperature test is less than 65°C (149°F), then the enclosure or frame need not comply with this requirement.

Exception No. 2: An enclosure or frame subjected to the Thermal Conditioning Test, Section 36 need not comply with this requirement.

5.4 An operating part such as a relay or similar device, shall be located such that it will not be exposed to dust or other material that might adversely affect its intended operation.

6 Means for Mounting

6.1 Means for permanent mounting of the luminaire shall be provided.

Exception No. 1: Luminaires intended to be installed only by manufacturers of recreational vehicles may be secured using plastic punching and riveting tools, provided that complete instructions are furnished. Instructions and installation tools shall be subject to investigation.

Exception No. 2: A mounting means other than holes, screws, or bolts is acceptable if equivalent support is provided, as determined by an investigation.

6.2 A hole, boss, and the like shall be arranged so that:

a) Support is provided; and

b) Firm seating of the mounting hardware, such as a screw or bolt, will not result in distortion of the bearing surfaces, cracking, breaking, or other adverse effects.

6.3 A luminaire shall be designed and constructed for mounting directly to the mounting surface and not for suspension by a chain or other means that would allow movement or swinging of the luminaire.

7 Thermal Insulation

7.1 Thermal insulation that is provided as part of a luminaire shall be secured in place as described in 7.2.

7.2 Thermal insulation is considered to be secured in place if it is attached to a luminaire by:

a) Two staples or bolts that will locate the insulation in the intended position;

b) An adhesive applied to at least one-third of the surface of the insulation;

c) A member of a luminaire that need not be removed for installation; or

d) An equivalent means.

Lead wires projecting through insulation are not acceptable for securing the insulation.

7.3 Thermal insulation that forms part of an enclosure shall comply with the applicable requirements in Frame and Enclosure, Section 5. All thermal insulation shall have a flammability rating of HB or better.

8 Corrosion Resistance

8.1 If corrosive action on an iron or steel part will result in a risk of fire, electric shock, or injury to persons, such part shall be made resistant to corrosion by enameling, varnishing, painting, galvanizing, plating, or a similar means.

9 Shades, Diffusers, Lenses, and Decorative Parts

9.1 A shade, diffuser, lens, or decorative part shall be of glass, metal, phenolic composition, or other material having a flammability rating of HB or better.

Exception: A bushing, wire tie, or other small part need not have a flame rating if it meets the following conditions:

a) Volume is less than 2 cubic inches (32 cm^3);

b) No dimension is greater than 3 inches (76.2 mm), and

c) Not in a position to propagate flame between 2 combustible materials.

9.2 A shade, diffuser, lens, or decorative part shall be positioned away from contact with any lamp.

10 Current-Carrying Parts

10.1 A current-carrying part shall have mechanical strength and ampacity in accordance with the intended use.

10.2 Steel used as a current-carrying part shall comply with Frame and Enclosure, Section 5, and its use shall be limited to those parts of a luminaire that primarily serve a mechanical function, such as a lampholder or a mounting frame.

11 Mounting of Components and Parts

11.1 A component such as a lampholder, switch, or other part of a luminaire assembly shall be restricted from loosening or turning if such motion may adversely affect the intended performance of a component or may result in a risk of fire.

11.2 The position of a lamp with respect to the enclosure or any other part of the luminaire shall be maintained during intended use and servicing.

11.3 A part used for the direct support of a current-carrying part shall be positioned such that possible movement will not reduce spacings below those specified in Spacings, Section 19.

11.4 The use of a lock washer, a star washer, dimples, upturned lugs, ears, or the equivalent to restrict movement is acceptable. Friction alone is not acceptable.

11.5 The center contact or contacts of a lampholder shall be securely positioned so that any movement will not reduce spacings below the minimum values specified in Spacings, Section 19. The center contact or contacts shall be secured both when the lamp is in place and when the lamp is removed. A center contact may be secured by positively routing the lead with a knot within 1/4 inch (6.35 mm) of the back of the lampholder. Friction or gravity alone is not considered an acceptable means of securement.

11.6 Rotation of a part of a luminaire assembly intended for rotation shall be limited to not more than 360 degrees if damage to wiring or any other electrical part is likely to result from rotation in excess of 360

12 Supply Connections

12.1 Two wire leads or terminals shall be provided for connection to the supply source.

12.2 Each supply lead shall be stranded, and shall be at least 5 inches (127 mm) but not more than 12 inches (305 mm) in length, as measured from the plane of the mounting surface or the back of a recessed luminaire. Each lead shall be of an ampacity compatible with the load to be served, but not smaller than 18 AWG (0.82 mm^2). Nongrounded supply leads shall have insulation that is rated:

a) A minimum 90°C (194°F); and

b) For the voltage of the luminaire, but not less than 300 volts in any case.

12.3 The lead to be connected to the grounded supply conductor shall be white, gray or bare, and the remaining lead a color other than green, white, or gray. The white or gray lead shall be connected conductively to the shell of a single-contact lampholder.

Exception: In a construction in which polarity identification of the leads is not significant, such as a luminaire provided with double-contact bayonet-base or bipost lampholders, the supply leads may be any color other than green.

12.4 A terminal provided for field supply connection shall be located so that disassembly of the luminaire (other than removal of a lens, shade, diffuser, or wireway cover) is not necessary in order to make the supply connections.

13 Cord Equipped Luminaire

13.1 A luminaire may be provided with a length of flexible cord terminated with an attachment plug or connector.

13.2 The flexible cord shall comply with Table 13.1.

Table 13.1
Acceptable types of flexible cord

C	S	SJ	SP-1	SP-2	SV[a]
HPN	SE	SJE	SPE-1	SPE-2	SVE[a]
PD	SEO	SJEO	SPT-1	SPT-2	SVEO
	SO	SJO			SVO[a]
	SOO	SJOO			SVOO[a]
	ST	SJT			SVT[a]
	STO	SJTO			SVTO[a]
	STOO	SJTOO			SVTOO[a]

[a] Individual conductors shall be provided with supplementary insulation or spaced away from metal.

13.3 A luminaire with a flexible cord shall be shipped with the cord mounted in place and connected.

Exception: The cord may be unconnected if the luminaire is provided with instructions that contain a wiring diagram and the strain relief device is provided.

13.4 A strain relief device shall be provided on a flexible cord. The device shall comply with the Strain Relief Test, 34.2.

13.5 The plug or connector shall have a configuration that cannot fit into a 120/240 volt receptacle.

14 Wiring

14.1 All wiring shall consist of general use wire or appliance wiring material rated for the temperature and voltage to which it is likely to be subjected and of an ampacity compatible with the intended use.

Exception: A conductor intended to be connected to ground need not be provided with insulation.

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

14.3 Each lead to an adjustable lampholder shall be of stranded wire and shall be of such length that adjustment of the lampholder will not transmit stress or cause damage to the lead or connection.

14.4 Supplementary insulation, such as coated-fabric or extruded thermoplastic insulating tubing, shall not be adversely affected by the temperature to which it is likely to be subjected during intended use.

15 Prevention of Wire Damage

15.1 The requirements in 15.2 – 15.5 do not apply to wiring intended to be connected to ground.

15.2 A luminaire shall be so constructed that wires can be pulled through, or the luminaire otherwise wired, without damaging the coverings of insulation on the conductors. A wire enclosure shall be free from burrs, fins, and other sharp edges that can come in contact with wires.

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

Exception: The requirement does not apply when wires are held away from or positioned away from the threads of sheet metal and self-tapping screws.

15.4 If a conductor passes through an opening or crosses over the edge of sheet-metal, it shall be held away from the edges of the metal or shall be protected by a bushing, a grommet, or by rolling the edge of the metal not 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.

15.5 A bushing used to comply with 15.3 shall be securely 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 (1.2 mm) thick is acceptable if an investigation shows that the mechanical properties contemplated are provided.

16 Wiring To A Lamp-Supported Lampholder

16.1 Wiring to a lamp-supported lampholder shall comply with the Strain Relief Test requirements in 34.1 and 34.3.

17 Electrical Connections

17.1 A splice or connection shall be secure and shall make an effective electrical connection.

17.2 A soldered connection shall be mechanically secured before soldering.

17.3 A splice shall be provided with insulation that has temperature and voltage ratings equal to or greater than those of the conductor insulation.

Exception: Insulation is not required on a splice or connection that is secured such that spacings are not reduced below those specified in 19.1.

18 Insulating Material

18.1 Materials in contact with live parts shall comply with 18.2 and 18.3.

18.2 Phenol, porcelain, and urea are acceptable insulating materials. The acceptability of other materials shall be determined by investigation.

18.3 Polymeric material used for the sole support of live parts shall comply with the requirements in the Standard for Polymeric Materials – Use In Electrical Equipment Evaluations, UL 746C among the factors to be considered are:

a) Resistance to Electrical Ingition Sources – Only the Hot Wire Ignition (HWI) shall be considered. The Performance Level Category (PLC) requirement depends on the flame rating of the material.

Flame rating	HWI PLC
HB	2
V-2	2
V-1	3
V-0	4

b) Flammability – minimum HB.

c) Temperature – The material shall have an electrical Relative Temperature Index (RTI), in accordance with Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, at least the temperature measured on the part during the normal temperature test.

19 Spacings

19.1 The spacing between live parts of opposite polarity and between a live part and a dead metal part shall not be less than 1/16 inch (1.6 mm). If an uninsulated live part is not secured in position by means other than friction between surfaces, or if a movable dead metal part is in proximity to an uninsulated live part, the construction shall be such that at least the minimum acceptable spacings will be maintained.

Exception No. 1: The spacing requirements do not apply to the inherent spacings of a component such as a switch or a lampholder. Such components shall comply with the spacing requirements for the component.

Exception No. 2: The spacing requirements do not apply between the outer shell of a single-contact lampholder and dead metal where the inherent construction of the lampholder results in direct connection of the outer shell to dead metal.

Exception No. 3: The clearance and creepage distance between conductive parts that are rigidly held in place and reliably spaced in production can be determined using the Standard for Insulation Coordination Including Clearances and Creepage Distances for Electrical Equipment, UL 840. Parts that are rigidly held in place and reliably spaced in production include conductors on a printed wiring board. The spacing requirements in UL 840 shall not be used for field wiring terminals or spacings to a dead metal enclosure. Creepage distances shall not be less than clearances.

20 Barriers

20.1 Materials in close proximity (less than 1/16 inch) to uninsulated live parts shall comply with 20.2 or 20.3 and be reliably secured.

20.2 A barrier or liner of insulating material that is used to maintain spacings shall not be less than 0.025 inch (0.64 mm) thick if the material is treated fiber or of phenolic composition. Other materials of the same or different thickness may be used if investigated and determined to be acceptable.

Exception: A barrier that is securely held in place and not exposed or otherwise subject to damage after installation shall not be less than 0.013 inch (0.33 mm) thick.

20.3 Polymeric material used in close proximity to live parts shall comply with 18.3 (a), (b), and (c).

21 Switches

21.1 A switch shall have current and voltage ratings in accordance with 21.2 and 21.3.

21.2 A switch used to control an incandescent lamp load shall have:

a) A current rating for a tungsten filament load equal to or greater than the current measured during the input test described in the Current Input Test, Section 27, or

b) If not rated for a tungsten filament load, a current rating at least 10 times the current measured during the input test.

Exception: A switch that has been investigated and determined to be acceptable for the intended use need not comply with the current rating requirements in (a) and (b) above.

21.3 A switch in a luminaire intended for nominal 12 volt dc use shall be rated not less than 14 volts dc.

Exception: A switch marked with the voltage rating "125 VT" is acceptable for controlling a tungsten load in a dc circuit provided the current rating of the switch is not less than the load controlled.

22 Lampholders

22.1 A lampholder may be a single- or double-contact bayonet-base or other type constructed for the intended lamp base. The lampholder shall be mounted in accordance with Mounting of Components and Parts, Section 11.

23 Cigarette Lighter Receptacles

23.1 A cigarette lighter receptacle may be provided in a luminaire rated a nominal 6 or 12 volts if:

a) The receptacle and terminals are enclosed in metal, and

b) The receptacle has an inner diameter of 0.840 – 0.845 inch (21.3 – 21.5 mm) if rated 6 volts or 0.824– 0.827 inch (20.9 – 21.0 mm) if rated 12 volts.

24 Tungsten-Halogen Luminaires

24.1 General

24.1.1 The requirements under this heading are supplementary to the other applicable requirements of this standard and apply to both recessed and surface-mounted luminaires incorporating a tungsten-halogen lamp.

24.2 Lamp containment barrier

24.2.1 A luminaire with a tungsten-halogen lamp shall be provided with a lamp containment barrier that complies with the requirements in 24.2.2 – 24.2.4. The lamp containment barrier shall limit the emission of quartz particles in accordance with 24.2.3.

Exception: A luminaire intended for use with a single-ended tungsten-halogen lamp with an integral outer envelope or a nonpressurized tungsten-halogen lamp and for which the lamp manufacturer does not require an enclosure need not be provided with a lamp containment barrier if the luminaire is marked in accordance with 38.6.

24.2.2 A lamp containment barrier shall not have any open holes greater than 1/8 inch (3.2 mm) diagonally or in diameter.

Exception: A lamp containment barrier may have open holes greater than 1/8 inch (3.2 mm) diagonally or in diameter if the openings are not line-of-sight between the lamp and any points outside the luminaire.

24.2.3 A lamp containment barrier shall be constructed of:

a) Metal – minimum 0.016 inch (0.41 mm) thick;

b) Heat resistance glass such as tempered, annealed or borosilicate glass – minimum 3/32 inch (2.38 mm) thick; or

c) Polymeric material complying with requirements in Section 35, Polymeric Lamp Containment Barrier.

If the lamp containment barrier also serves as an enclosure, it shall additionally comply with 5.3.

24.2.4 A lamp containment barrier shall be secured in position by:

a) A mechanical means that produces an interference fit;

b) Physical fit; or

c) Other similar means.

25 Wet Locations

25.1 A luminaire intended for use in wet locations shall be tested in accordance with 30.2 and 30.3. Results are acceptable if water does not accumulate on any electrical part or within the luminaire and supply connections are prevented from contact with water.

25.2 A water shield formed of a polymeric material shall possess a mechanical impact Relative Temperature Index (RTI), in accordance with Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, of at least the temperature measured on the part during the normal temperature test.

Exception No. 1: When the temperature measured during the normal temperature test is less than 65°C (149°F), then the water shield need not comply with this requirement.

Exception No. 2: A water shield subjected to the Thermal Conditioning Test, Section 36, need not comply with this requirement.

25.3 A luminaire part that is constructed of material other than metal, polymer, or glass shall be tested in accordance with the Water Absorption Test, Section 31.

Exception: An electrical component need not be tested.

25.4 A gasket or bushing employed to comply with Section 25 shall be subjected to the Gasket Tests, Section 32.

25.5 An adhesive used to secure a gasket as described in 25.4 shall be subjected to the Gasket Adhesion Test, Section 33.

PERFORMANCE

26 General

26.1 A luminaire shall be tested in accordance with Sections 27 – 38.

26.2 Material used in the construction of a luminaire shall not be adversely affected by the temperature attained when tested in accordance with the Temperature Test, Section 28, and the Abnormal Operation Test, Section 29.

26.3 Acceptability of an adhesive shall be based on:

a) The degree of reliance placed on the adhesive for securement in the construction of the luminaire; and

b) The applicable requirements in the Standard for Polymeric Materials – Use In Electrical Equipment Evaluations, UL 746C.

27 Current Input Test

27.1 Input current and power shall be measured with the luminaire connected to a supply circuit and operating as intended. The potential of the supply circuit shall be in accordance with Table 27.1.

Table 27.1
Test potential (dc volts) to be applied

Nominal circuit voltage	Voltage during input and temperature test	Voltage during abnormal operation test
6	7	7.75
12	14	15.50
24	28	31.00

28 Temperature Test

28.1 The test luminaire with lamp or lamps, is to be mounted to the test panel illustrated in Figure 28.1. Any lampholder that can be moved is to be adjusted to the most severe position with respect to the enclosure and other parts of the luminaire. The luminaire is to be connected to a direct current supply voltage adjusted to the value specified in Table 27.1. The luminaire is to be fitted with the number and type of lamps marked, with the maximum recommended wattage specified in 38.3 or 48.1, as appropriate. If the installation instructions provided indicate another type of mounting, the luminaire is to be tested in accordance with the installation instructions.

28.2 A luminaire is to be tested with the test panel oriented vertically or horizontally, whichever will result in the more severe operating condition.

Exception No. 1: A luminaire marked in accordance with 38.4 is to be tested as marked; that is, with the test panel positioned horizontally for a ceiling-mounted luminaire, or vertically for a wall-mounted luminaire.

Exception No. 2: A luminaire that, by its appearance, is obviously suited for mounting only in one orientation is to be tested in the intended mounting position.

28.3 The test is to be continued until constant temperatures are obtained. A temperature is considered to be constant if:

a) The test has been running for at least 3 hours; and

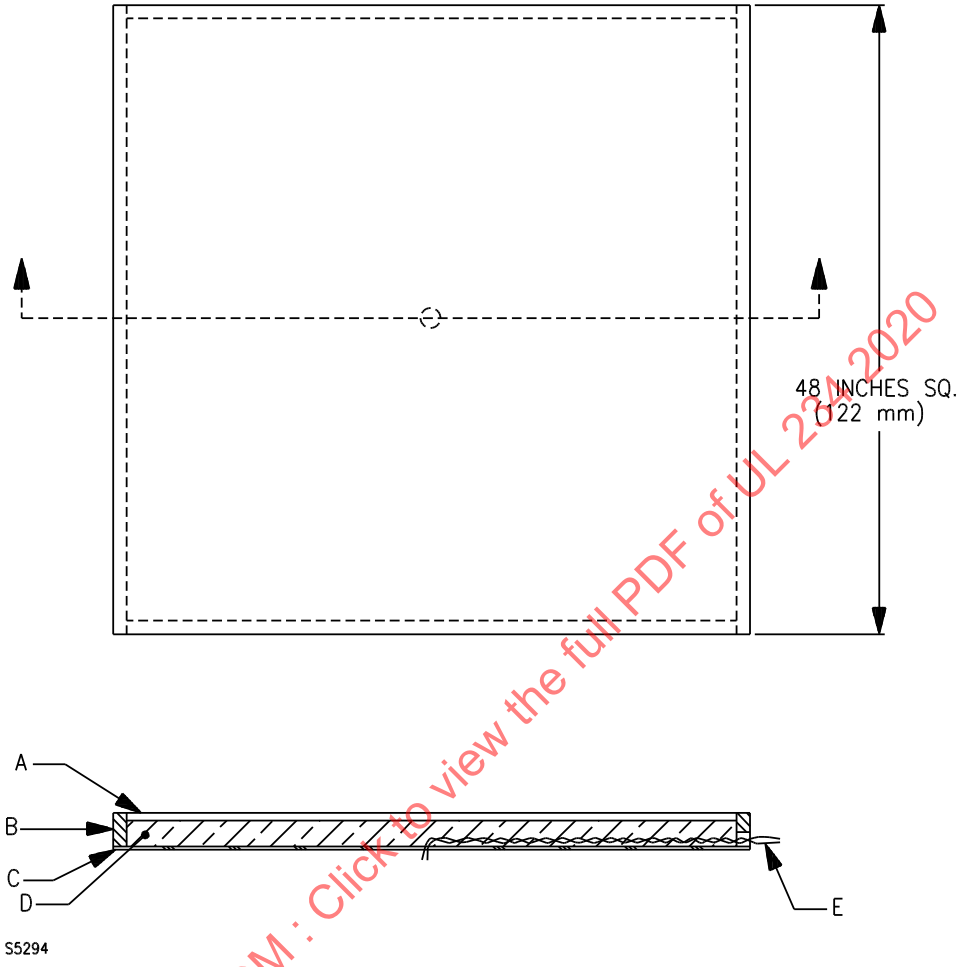
b) Three successive readings, taken at 15-minute intervals, are within 1°C (1.8°F) of one another and are still not rising.

28.4 A thermocouple junction and the adjacent thermocouple lead wire are to be held securely in thermal contact with the surface area being measured. Thermocouples should be placed on the hottest accessible locations.

28.5 A thermocouple is to consist of wires not larger than 24 AWG (0.21 mm^2) and not smaller than 30 AWG (0.05 mm^2). It is common practice to use a thermocouple consisting of 30 AWG iron and constantan wires and a potentiometer-type indicating instrument; such equipment is to be used whenever referee temperature measurements by thermocouples are necessary. The thermocouple wire is to conform with the requirements specified in the Initial Calibration Tolerances for Thermocouples table in Temperature Measurement Thermocouples, ANSI/ISA MC96.1.

Figure 28.1

Test panel



A – Aluminum sheet 0.020 inch (0.51 mm) thick

B – Wood framework 3/4 inch x 2-5 inch (19 mm x 63.5 mm) all around perimeter

C – Faced (one side) mineral and fiberboard 1/4 inch (6.4 mm) thick

D – Fiberglass thermal insulation 2 inches (50.8 mm) thick

E – Supply Leads – Supply connection is made by two leads. 14 AWG (2.1 mm^2), rated at least 90°C (194°F), routed between the fiberglass insulation and the front panel to the 1.5 inch (38.1 mm) supply connection hole

Construction will allow an approximate 1/2 inch (12.7 mm) airspace between the aluminum sheet and the fiberglass insulation

28.6 The maximum acceptable temperature rises for commonly used materials are as specified in Table 28.1 and are based on an assumed ambient temperature of 25°C (77°F); tests may be conducted at any ambient within the range of 20 – 30°C (68 – 86°F). The ambient temperature is to be measured by means of a thermocouple immersed in a bath of mineral oil in a glass container, or other means equivalently immune to air turbulence or convection currents.

Table 28.1
Maximum acceptable temperature rise

Component location	°C	°F
All Luminaires		
1. Point of connection of supply wires	65	117
2. Lampholder body of thermosetting material (phenolic, urea, and the like)[b]	125	225
3. Varnished cloth insulation[b]	60	108
4. Fuse	65	117
5. Fiber employed as electrical insulation[b]	65	117
6. Wood	65	117
7. Copper conductor (bare or insulated) without a nickel coating or equivalent protection	125	225
8. Termination of copper conductor and pressure terminal connectors without a nickel coating or equivalent protection	125	225
9. Lampholder screw shell, center contact, or other connecting device of aluminum or unplated copper	175	315
10. Polymeric material used for enclosure or structural parts	c	c
11. Surface to which a marking label is attached	d	d
12. Wire or cord	e	e
13. Points of luminaire support in contact with the mounting surface	65	117
14. Surfaces upon which a luminaire may be mounted and surfaces that may be adjacent to the luminaire when it is mounted	65	117
Recessed Luminaires		
15. Screen shield, or recessed housing in contact with insulation	65	117
16. On non thermosetting sealing compound	f	
Wet Location Luminaires		
17. On thermoplastic watersheilds	40[g]	104
18. On gaskets	h	

[a] The temperature rise is not limited to 65°C (117°F) when the luminaire is provided with supply leads 5 – 12 inches (127 – 305 mm) long and the luminaire is marked with the word "Caution" and the following or equivalent: "Risk of fire. Route field wiring away from luminaire."

[b] These limitations do not apply to compounds or components that has been investigated and found acceptable for a higher temperature.

[c] The investigation of a polymeric material shall comply with requirements in Section 5, Frame and Enclosure.

[d] The maximum temperature, when corrected to a 25°C (77°F) ambient temperature, is the temperature rating of a label that is used.

[e] The maximum temperature, when corrected to a 25°C (77°F) ambient temperature, is the temperature rating of the wire or cord used.

[f] The maximum sealing compound temperature, when corrected to a 25°C (77°F) ambient temperature, is 15°C (27°F) less than the softening point of the compound as determined by the Standard Test Method for Softening Point by the Ring and Ball Apparatus, ASTM E28.

[g] Not applicable when the material is rated for a higher temperature, in accordance with 25.2.

[h] The maximum temperature of the material is acceptable when the material complies with Section 32, Gasket Tests.

28A Direct Contact Temperature Test

28A.1 A luminaire intended to be marked as suitable for direct contact with bedding material, per 38.7, shall additionally be tested per this section.

28A.2 The setup shall be in accordance with the Temperature Test, Section 28, with the addition of a fabric-covered foam pad fully covering the lens of the luminaire and extending in each direction no less than 6 inches (152 mm). The foam pad shall be 6 inches (152 mm) thick, of a density no greater than 1.8 lb/ft^3 (29 kg/m^3), and shall be pressed up against the luminaire with a force of 10.0 ±0.5 pound (44.5 ±2 N). The fabric covering of the pad shall be untreated cotton, 120-210 threads per square inch and 3.7 ±0.8 oz/yd^2 (125 ±28 gm/m^2).

28A.3 The test panel (see Figure 28.1) shall be oriented vertically or horizontally, whichever will result in the more severe operating condition, unless the luminaire is obviously suited for mounting only in one orientation and is so identified in the installation instructions.

28A.4 The test is to be continued for at least 3 hours and until three successive readings, taken at 15-minute intervals, are within 1°C (1.8°F) of one another and are not rising.

28A.5 Temperatures on the lens surface shall not exceed 65°C (149°F).

29 Abnormal Operation Test

29.1 The temperature test described in Temperature Test, Section 28, is to be repeated with the supply voltage adjusted to the abnormal operation value specified in Table 27.1 for not less than 5 hours and not more than 7 hours. Results are acceptable if there is no distortion resulting in movement of a lamp or lampholder, no distortion of any material forming part of the enclosure, or no other adverse condition.

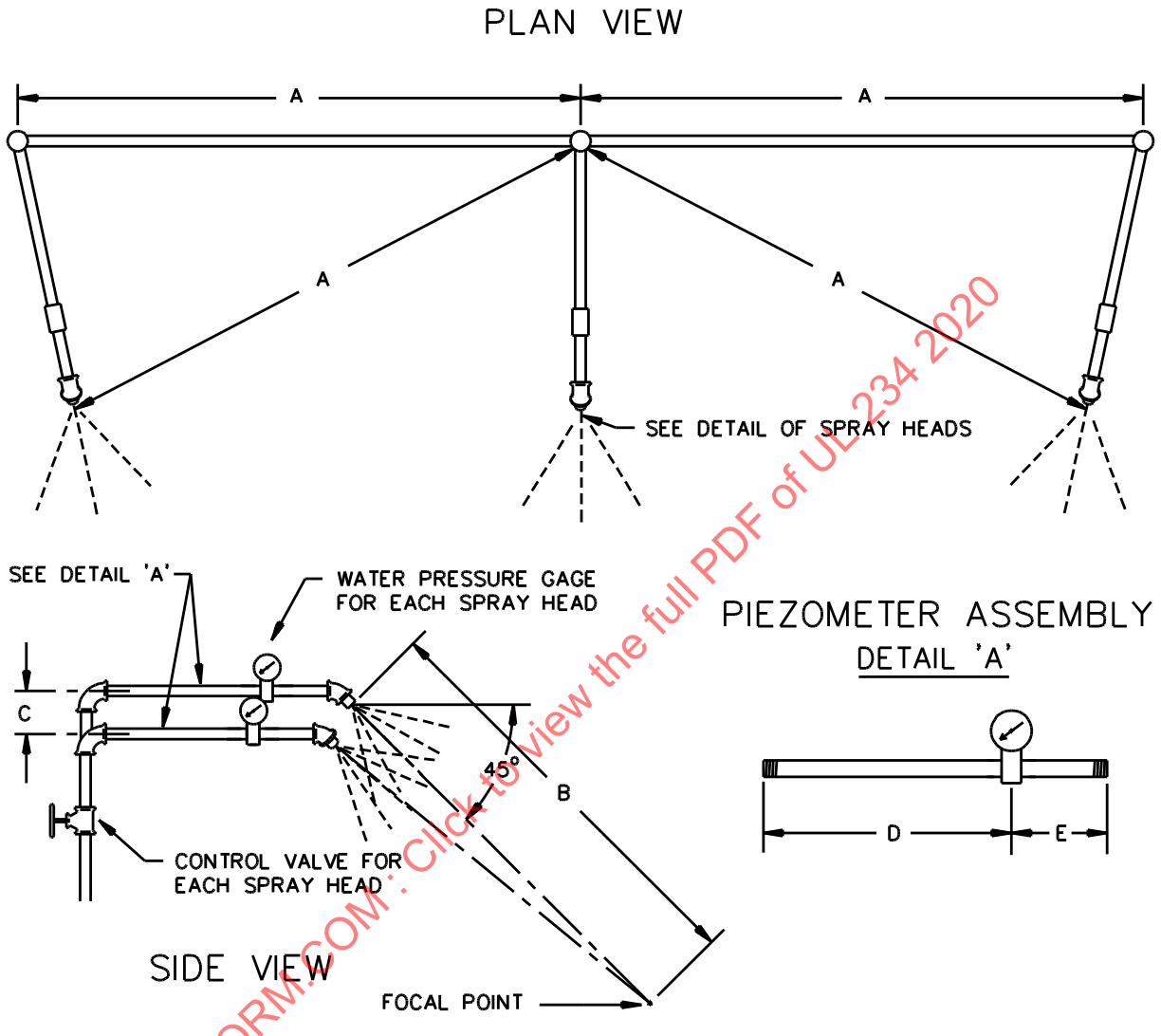
30 Water Spray Test

30.1 The luminaire, complete with the lamp or lamps with which it is intended to be used is to be mounted as intended under the most adverse mounting conditions to which it may be subjected in use.

30.2 The water spray test apparatus for a wall-mounted luminaire is to consist of three spray heads mounted in a pipe rack as illustrated in Figure 30.1. Spray heads are to be constructed in accordance with the details shown in Figure 30.2. The water pressure at each spray head is to be maintained at 5 pounds per square inch (34.5 kPa). The distance between the center spray head and the luminaire is to be approximately 5 feet (1.5 m). The luminaire is to be brought into the focal area of the three spray heads in such a position that the greatest quantity of water is likely to enter the enclosure. The spray is to be directed at an angle of 45 degrees to the vertical toward the luminaire for 1 hour.

Figure 30.1

Spray head piping



Item	inch	mm
A	28	710
B	55	1400
C	2–1/4	55
D	9	230
E	3	75

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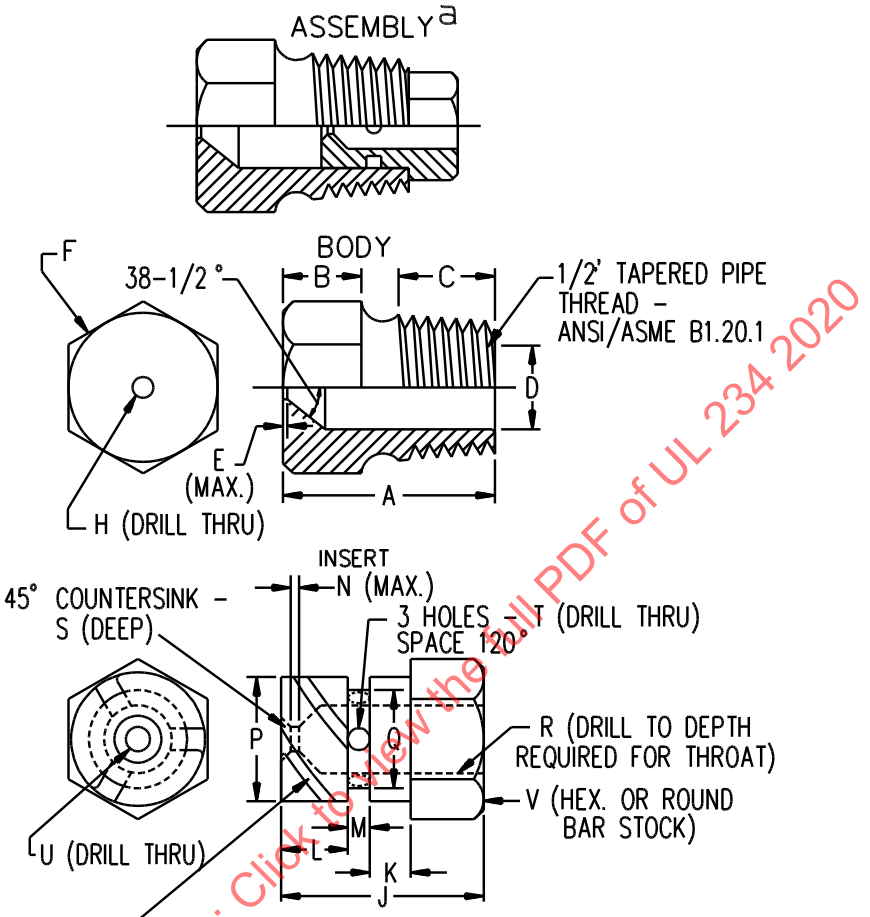
Figure 30.2

Spray head



Item	inch	mm	Item	inch	mm
A	1-7/32	31.0	N	1/32	0.80
B	7/16	11.0	P	.575	14.61
C	9/16	14.0		.576	14.63
D	.578	14.68	Q	.453	11.51
	.580	14.73		.454	11.53
E	1/64	0.40	R	1/4	6.35
F	c	c	S	1/32	0.80
G	.06	1.52	T	(No. 35)[b]	2.80
H	(No.9)[b]	5.0	U	(No. 40)[b]	2.50
J	23/32	18.3	V	5/8	16.0
K	5/32	3.97	W	0.06	1.52
L	1/4	6.35			
M	3/32	2.38			

[a] Nylon Rain–Test Spray Heads are available from Underwriters Laboratories

[b] ANSI B94.11M Drill Size

[c] Optional – To serve as a wrench grip.

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30.3 The water spray test apparatus for a ceiling-mounted luminaire is to consist of a single standard spray head as described in 30.2 and illustrated in Figure 30.2. The luminaire is to be mounted as intended and the spray head is to be positioned such that the greatest amount of water is likely to enter the enclosure. The distance from the center spray head to the luminaire is to be approximately 5 feet (1.5 m). The water pressure is to be maintained at 15 pounds per square inch (103 kPa). The duration of the test is to be 1 hour.

31 Water Absorption Test

31.1 A luminaire part as described in 25.3 shall be tested in accordance with 31.2 – 31.4.

31.2 Each of three samples of the luminaire, with all electrical components removed, is to be carefully weighed, and the weight of each is to be recorded.

31.3 Each sample is to be immersed in tap water at 23 ±2°C (73.4 ±4°F) for 24 hours, after which it is to be removed, dried with a dry cloth to remove surface water, and carefully reweighed.

31.4 Results are acceptable if, for each sample, any increase in weight does not exceed 2 percent of the original (dry) weight.

32 Gasket Tests

32.1 A gasket or bushing employed to comply with the water spray test requirements shall, after conditioning for 168 hours in a circulating air oven at a temperature of 20°C (36°F) above the temperature measured on the gasket or bushing during the temperature test, have a tensile strength of not less than 60 percent and an elongation of not less than 60 percent of the values determined before conditioning.

Exception No. 1: This test need not be conducted if a gasket or bushing is tested while installed in the unit as described in Section 33, Gasket Adhesion Test.

Exception No. 2: Neoprene rubber is acceptable for 60°C (140°F) and silicone rubber is acceptable for 105°C (221°F) without being subjected to the test.

32.2 As an alternative to the test described in 32.1, a gasket or bushing shall be tested as follows. With the gasket(s) or bushing(s) in place, the luminaire is to be conditioned in a circulating air oven for 240 hours at 20°C (36°F) above the temperature measured during the Temperature Test, Section 28. After the conditioning, any panels which depend on the gasket or bushing for sealing are to be opened. The results are acceptable if a visual inspection shows no damage to the gasket and the gasket has remained in place. The luminaire panels are then to be closed and the unit subjected to the water spray test, as appropriate.

32.3 In regard to 32.2, if the luminaire is provided with more than one gasket and if the temperature rise measured on the gasket material during the temperature test is not the same for all gaskets, then the test described in 32.2 may be conducted at the accelerated aging condition corresponding to the highest temperature rise for the gaskets. Otherwise, a separate luminaire will need to be tested at each measured temperature rise on the gaskets.

33 Gasket Adhesion Test

33.1 In accordance with 25.5, a gasket secured by an adhesive shall be tested as follows. The force required to remove the gasket from its mounting surface is to be measured while pulling on the edge of the gasket in plane perpendicular to the surface on which the gasket is mounted. Six samples of the gasket assembly are then to be subjected to the gasket conditioning described in 32.1 and 32.2, as appropriate. The force required to remove the gaskets from the mounting surface is to be measured within 1/2 hour

after completion of the conditioning for three of the samples, and 24 hours after the conditioning for the remaining three samples. The results are acceptable if the force necessary to remove the gasket rom its mounting surface is at least 60 percent of the value measured prior to the conditioning.

34 Strain Relief Test

34.1 A strain relief device for the wires of a lamp-supported lampholder is to be tested by the application of a 20 pound (89 N) pulling force on the wires for 1 minute. The result is acceptable if the pull is not transmitted to terminals, splices, or internal wiring.

34.2 A strain relief device is to be tested by a 35 pound pull force (156 N) on the cord connected luminaires for 1 minute. The result acceptable if the pull is not transmitted to terminals, splices, or internal wiring.

34.3 In testing in accordance with 34.1 and 34.2, the conductors are to be severed immediately adjacent to the terminals or splices. The pull is to be applied to the wire in a direction perpendicular to the plane of the entrance to the luminaire. Movement of any wire more than 1/16 inch (1.6 mm) at the point where it is severed is not acceptable.

35 Polymeric Lamp Containment Barrier

35.1 General

35.1.1 These requirements apply only to that part of a lamp containment barrier that is of a polymeric material and is intended to be provided in a luminaire in a location where particles from a ruptured tungsten-halogen lamp are likely to drop to and rest.

35.1.2 A polymeric material shall be subjected to the plastic flammability/containment test described in 35.2 to determine its suitability for use as a lamp containment barrier.

35.2 Test method

35.2.1 Three samples of the lamp containment barrier to be tested, are to be supported by their outer edges and oriented as they would be during normal operation. A surface located 12 inches (305 mm) below the test samples is to be covered by a layer of dry absorbent cotton that is nominal 1/4 inch (6.4 mm) thick.

35.2.2 During the test, each sample of the lamp containment barrier material is to be heated to and maintained at the maximum operating temperature for each thickness of material recorded when tested in accordance with the Temperature Test, Section 28.

35.2.3 Three cylindrical arc tube segments as specified in Table 35.1, are to be preheated to 1100°C (2012°F) for a minimum of 15 minutes.

35.2.4 Each arc tube segment is then to be placed on the barrier such that the longitudinal axis of the cylinder is perpendicular to the plane of the barrier. The transfer of each arc tube segment from the oven to the surface of the containment barrier shall not exceed 2 seconds.

Table 35.1
Quartz arc tube test segments

Outside diameter		Wall thickness		Length	
inch	(mm)	inch	(mm)	inch	(mm)
0.55	(14.0)	0.040	(1.0)	1/4	(6.4)

35.2.5 The results are considered acceptable if, during the testing of the samples, the dry absorbent cotton located below the test samples is not ignited by:

a) Flaming drips of plastic material; or

b) Any arc tube segment that penetrates the lamp containment barrier material and falls on the cotton.

36 Thermal Conditioning Test

36.1 A polymeric material, used as a frame, enclosure, or wet location water shield that is subjected to an operating temperature in excess of 65° C (149° F) as determined by the temperature test shall be exposed to a 1000 hour oven test. The temperature used for this test shall be 10°C (18°F) higher than the highest temperature attained in the normal temperature test. After testing, the parts shall retain their original dimensions and shape. The lamp used for the temperature test shall be as intended and marked on the luminaire, or, if the luminaire is not provided with a lamp replacement marking, the largest lamp wattage and size that will physically fit in the luminaire. Exposure time may be reduced by one-half for each increase in oven temperature of 10°C (18°F). If the sample is too large for the test oven, the sample may be cut to fit.

37 Impact Test

37.1 The impact specified in 5.3 is to be produced by dropping 1 pound (0.45 kg) of #7 1/2 (.095 inch, 2.41 mm) lead shot, enclosed in a plastic bag formed into an approximate 2 inch (50.8 mm) diameter sphere, from the height necessary to produce the desired impact. The height is to be 36 inches (914 mm) for a 3 foot-pound (4.1 N·m) impact.

MARKINGS

38 General

38.1 A luminaire shall be plainly and permanently marked with the manufacturer's name or trademark, a distinctive catalog number or the equivalent, the voltage ratings, and "For Recreational Vehicle Use Only," or the equivalent. Pressure-sensitive labels secured by adhesive shall comply with the requirements in the Standard for Marking and Labeling Systems, UL 969.

38.2 If instructions are necessary for the intended installation, operation, or maintenance of the equipment, such information shall be provided and shall be permanently attached to the equipment or made part of the instruction manual.

38.3 The lamp trade number designation applicable to a low voltage circuit shall be marked, at a point where visible during relamping, in paint-stenciled, die-stamped, or indelibly stamped lettering, or on a self-adhesive label adjacent to each lampholder. The luminaire shall be plainly marked with the word "CAUTION" and the following or the equivalent: "Risk of fire. Use only lamp trade No. _____." The lamp number designation shall be in the blank space in the marking. The lettering in the marking shall be at least 1/16 inch (1.6 mm) high.

38.4 A luminaire tested in accordance with Exception No. 1 to 28.2 shall be marked to indicate the intended mounting position. The marking shall be visible during installation and shall be in paint-stenciled, die-stamped, or indelibly stamped lettering or on a self-adhesive label. The lettering shall be at least 1/8 inch (3.2 mm) high.

38.5 A luminaire suitable for use in wet locations in accordance with the Water Spray Test, Section 30, and the Water Absorption Test, Section 31, shall be marked "Suitable for wet locations." The marking shall be visible during installation and shall be in paint-stenciled, die-stamped, or indelibly stamped lettering or on a self-adhesive label. The lettering shall be at least 1/8 inch (3.2 mm) high.

Exception: The acceptability of other forms of marking may be determined by investigation.

38.6 A luminaire with a single-ended tungsten-halogen lamp that complies with the exception to 24.2.1 shall be marked with the word "CAUTION" and the following or the equivalent: "To reduce the risk of fire do not use a lamp identified for use in enclosed luminaires."

38.7 A luminaire suitable for use where it may come into contact with combustible materials and tested in accordance with the Direct Contact Temperature Test, Section 28A, is permitted to be marked “Suitable for direct contact with bedding or other combustible material.” The marking shall be visible during installation and shall also be provided on the smallest product packaging and in the installation instructions.

PART 2 – FLUORESCENT LUMINAIRES

GENERAL

39 Scope

39.1 These requirements apply to fluorescent, low voltage luminaires. They do not apply to incandescent luminaires.

39.2 A low voltage fluorescent luminaire shall comply with the applicable requirements in Part supplemented by, and in some cases amended by, the requirements in Sections 40 – 48.

CONSTRUCTION

40 Frame and Enclosure

40.1 An electrical part shall be located or enclosed so as to reduce the risk of unintentional contact with an uninsulated live part.

Exception No. 1: An uninsulated live part operating at an open circuit potential of not more than 42.4 volts peak, or one in which the actual current would be not more than 5 mA through a 1500-ohm resistor, need not be so located or enclosed.

Exception No. 2: A lampholder that complies with the requirements in the Standard for Fluorescent Lamp Starters, UL 542, need not be so located or enclosed.

40.2 An uninsulated live part, other than that described in Exception No. 2 to 40.1, in a compartment that is opened by service personnel as intended for servicing a fuseholder, lampholder, switch, circuit breaker, or the like shall be located or guarded so that it cannot be inadvertently contacted by the service personnel while performing that operation.