UL 1149

Underwriters Laboratories Inc.

Standard for Safety

Low Voltage Marine Lighting Fixtures

UL Standard for Safety for Low Voltage Marine Lighting Fixtures, UL 1149

Second Edition, Dated September 28, 2009

Summary of Topics

This new edition of UL 1149 is being issued to address universal upkeep of UL Standards for Safety. These revisions are considered to be non-substantive and not subject to UL's STP process.

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

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Standard for Low Voltage Marine Lighting Fixtures

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

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PART I – ALL FIXTURES

INTRODUCTION

1 Scope

1.1 These requirements apply to incandescent and fluorescent marine lighting fixtures rated 36 volts (nominally) or less using an AC or DC source of power.

1.2 The lighting fixtures covered by these requirements are intended for installation and use in accordance with the applicable requirements of the U.S. Coast Guard, the standards of the American Boat and Yacht Council, Inc., and the Standard for Fire Protection of Pleasure and Commercial Motorcraft, NFPA 302.

1.3 These requirements do not cover marine lighting fixtures for use in hazardous locations as defined in the United States Coast Guard Electrical Engineering Regulations.

1.4 These requirements also do not cover navigation lights, floating water lights, or emergency lights.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the 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 does not comply with this standard. 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 Units of measurement

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

2.2 Terminology

2.2.1 The term ″fixture″ refers to all incandescent, halogen, and fluorescent marine lighting fixtures or any part thereof covered by this standard unless specifically noted otherwise.

3 Components

3.1 Except as indicated in 3.2, a component of a lighting fixture 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 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.

CONSTRUCTION

4 General

4.1 An external edge, projection, or corner shall be smooth, rounded, and not sufficiently sharp to cause a laceration injury in intended use and maintenance.

4.2 Means shall be provided for securely fastening the fixture.

4.3 Lock washers or other acceptable means shall be provided to reduce the likelihood of fastenings being loosened due to vibration and shock.

4.4 A non watertight fixture shall be provided with a means of draining the device to reduce the likelihood of water accumulation around electrical components.

4.5 A fixture with glass or plastic enclosures made for installation in machinery spaces or other similar areas shall be protected with guards against inadvertent breakage (see Vibration Test, Section 20).

4.6 Inverter ballasts, toroids, and other electronic components used in fluorescent fixtures shall be potted or protected against dampness and vibration. Heat sinks shall be provided as required.

4.7 A fluorescent fixture shall be enclosed or electrically filtered so as not to interfere with radio reception on the marine frequencies (see 33.2).

4.8 A fixture shall be 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 fixture.

4.9 Acceptability of an adhesive shall be based on the following:

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

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

5 Materials

5.1 The materials used for the construction of marine lighting fixtures shall have the mechanical, electrical, and chemical resistance characteristics appropriate for a marine environment.

5.2 Housing brackets, trim, and other non current carrying parts shall be made of non ferrous metal alloys, ferrous metal alloys coated for protection against corrosion in a salt atmosphere, or nonmetallic materials.

6 Enclosure

6.1 A frame and enclosure shall be so formed and assembled 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, electric shock, or injury to persons due to total or partial collapse, with resulting reduction of spacings, loosening or displacement of parts, or similar effects.

6.2 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 found 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.

6.3 An enclosure or frame formed of a nonmetallic material may be employed if, upon investigation, the material exhibits properties equivalent to that addressed in 6.1. Among the factors to be considered are:

a) Mechanical strength;

b) Combustibility;

c) Resistance to distortion at temperatures likely to be encountered in service;

d) Resistance to arcing; and

e) Moisture absorption.

For a polymeric enclosure, all these factors are to be considered with respect to thermal aging.

6.4 All energized metallic parts shall be enclosed or protected to reduce the risk of unintentional contact when the fixture is installed.

6.5 A terminal connection shall be protected by an enclosure or housing intended to shield against inadvertent contact that could cause short circuiting from tools or other objects, as well as to shield against drip and spray.

7 Corrosion Protection

7.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, zinc or cadmium plating, or other equivalent means. The composition of metallic alloys shall provide corrosion resistance at least equivalent to stainless steel 304.

7.2 Metal combinations shall be galvanically compatible.

7.3 A material not known to provide acceptable resistance to corrosion, dezincification resistance, and galvanic compatibility between parts shall comply with the Salt Spray Corrosion Test, Section 22.

8 Shades, Diffusers, Lenses, and Decorative Parts

8.1 A shade, diffuser, lens, or decorative part shall be of glass, metal, phenolic composition, or other material having a minimum flammability rating of HB when tested in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

Exception: A bushing, wire tie, or other small part need not be so rated if it would contribute negligible fuel to a fire, and is located at least 0.5 inch (12.7 mm) from an uninsulated electrical part not connected in a low voltage, power limited circuit.

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

9 Current-Carrying Parts

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

9.2 A current-carrying part of the device including terminals, nuts, washers, and terminal connectors shall be made of copper, bronze, brass, or other corrosion resistant metal or alloy having electrical and mechanical properties appropriate for the intended usage.

10 Mounting of Components and Parts

10.1 A component such as a lampholder, switch, or other part of a fixture 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.

10.2 A lampholder shall be held in place such that the position of the lamp with respect to the enclosure or other part of the fixture is maintained during intended use and servicing.

10.3 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 16.

10.4 Friction alone is not acceptable to restrict movement, but the use of a lock washer, a star washer, dimples, upturned lugs, ears, or the equivalent is acceptable for this purpose.

10.5 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 16, both with the lamp in place and with the lamp removed. Friction or gravity alone is not considered an acceptable means of securement, but positive routing by a right angle bend in the lead within 0.5 inch (12.7 mm) of the back of the lampholder is acceptable for this purpose.

10.6 Rotation of a part of a fixture assembly constructed for rotation shall be limited to no more than 360 degrees if damage to wiring or any other electrical part is likely to result from rotation in excess of 360 degrees.

11 Supply Connections

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

11.2 Each supply lead shall be stranded copper with a minimum of 16 strands, and shall be at least 5 inches (127 mm) but no more than 12 inches (304 mm) in length, as measured from the plane of the mounting surface or the back of a recessed fixture. Each lead shall be of an ampacity compatible with the load to be served. Conductors shall be 16 AWG (1.3 mm^2) or larger if single and 18 AWG (0.82 mm^2) or larger if in a multiconductor sheath and shall be one of the following types:

a) A stranded copper conductor that has insulation complying with the moisture resistance and flame retardance requirements in Article 310 of the National Electrical Code, ANSI/NFPA 70-1993;

b) A standard copper conductor that complies with the Standard for Electrical Cables for Boats, UL 1426;

c) A stranded copper conductor that complies with the insulating material temperature rating requirements in the Recommended Practice for Marine Engine Wiring, SAE J378C (June 1978); or

d) A flexible cord type SO, SOO, ST, STO, STOO, SJO, SJOO, SJT, SJTO, or SJTOO.

11.3 Each supply lead shall have insulation rated for the maximum rated temperature (as determined in accordance with the Temperature Test, Section 28) and voltage of the fixture, but no less than 300 volts in any case. Supply lead insulation shall be at least 1/32 inch (0.8 mm) thick.

11.4 The lead to be connected to the grounded supply conductor shall be white or gray, 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 fixture employing double contact bayonet base or bipost lampholders, the supply leads may be any color other than green.

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

12 Wiring

12.1 Internal wiring must be stranded and rated for a minimum of 300 volts. It 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.

12.2 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.

12.3 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.

13 Wireways

13.1 A wire within an enclosure, compartment, or raceway shall be so located that:

a) It will not contact any rough or sharp part; and

b) The temperature rating of the conductor will not be exceeded during intended use.

13.2 A hole in a sheet metal wall through which conductors are routed shall be treated or formed to eliminate sharp edges with which wiring can come into contact.

13.3 An eyelet, bushing, and rolled edge are acceptable means for compliance with the requirement in 13.2. The use of a rubber bushing alone is not acceptable.

14 Electrical Connections

14.1 A splice or connection, such as a pressure type or crimp on connector, shall be mechanically secured and shall make an effective electrical connection. Wire connectors shall comply with the requirements in the Standard for Wire Connectors, UL 486A-486B.

14.2 A soldered connection shall be mechanically secured within 1 inch (25.4 mm) of the connection on both sides of the connection.

14.3 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 16.1.

15 Insulating Material

15.1 An uninsulated live part shall be mounted on or supported by insulating material as described in 15.2.

15.2 Phenolic and urea are acceptable insulating materials. The acceptability of other materials shall be determined by investigation. Among the factors to be considered are resistance to ignition, flame propagation, mechanical strength, rigidity, resistance to distortion, and other physical properties.

15.3 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.

16 Spacings

16.1 The spacing between live parts of opposite polarity and between a live part and a dead metal part shall be not 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.

17 Barriers

17.1 A barrier or liner of insulating material that is used to maintain spacings shall be not 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 found acceptable.

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

18 Switches

18.1 A switch shall have current and voltage ratings in accordance with 18.2 and 18.3.

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

a) A DC current rating for a tungsten filament load equal to or greater than the current measured during 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 Current Input Test.

18.3 A switch in a fixture 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 no less than the load controlled.

18.4 A switch enclosure shall be electrically insulated from contacting dead metal parts of a fixture.

19 Lampholders

19.1 A lampholder may be a single or double contact bayonet base or other type appropriate for the intended lamp base. The lampholder shall be mounted in accordance with Mounting of Components and Parts, Section 10, and shall be marked in accordance with 32.9.

19.2 A medium base lampholder shall not be employed.

19.3 An edison based lampholder shall comply with the Standard for Lampholders, UL 496.

PERFORMANCE – MECHANICAL

20 Vibration Test

20.1 A fixture shall be able to withstand the vibration conditioning described in 20.2 – 20.5 without any loosening of parts or reductions in spacings that may result in risk of fire or electric shock.

Exception: A fixture marked for use on vessels over 65 feet (20 m) in length in accordance with 32.7 need not be subjected to this test.

20.2 The fixture, including all components, is to be mounted on a vibration table so as to simulate as closely as possible an actual installation on a boat in accordance with the manufacturer's installation instructions. The means used for such mounting shall be sufficiently rigid to avoid resonant frequencies of the mounting means. The vibration table is to produce the vibration frequencies and amplitude specified 20.3.

20.3 The fixture is to be subjected to variable frequency vibration along each of three rectilinear orientation axes (horizontal, lateral, and vertical) for 4 hours in each plane (12 hours total) at a peak to peak amplitude of 0.015 ±0.001 inch (0.4 ±0.05 mm). The frequency of vibration is to be continuously varied, at a uniform rate, from 10 to 60 to 10 hertz every 4 minutes.

20.4 During the test, the fixture shall be operated at rated input voltage for the final hour in each plane.

20.5 For this test, peak to peak amplitude is defined as the maximum displacement of sinusoidal motion (total table displacement).

21 Shock Test

21.1 The same fixture subjected to the Vibration Test, Section 20 shall be able to withstand the shock 21.2 and 21.5 without any loosening of parts or reductions in spacings that may result in risk of fire or electric shock.

Exception: A fixture marked for use only on vessels over 65 feet (20 m) in length in accordance with 32.7 need not be subjected to this test.

21.2 The fixture is to be mounted on a shock machine in the same manner as described in the vibration conditioning specified in 20.2 and 20.3. The shock machine is to produce vertical repeated shock pulses as specified in 21.3.

21.3 The sample is to be subjected to 1000 shock impacts of 10 g acceleration (98 m/s^2) and having a shock duration of 20 – 25 milliseconds as measured at the base of the half sine shock envelope.

21.4 The machine used for this conditioning is to be of the automatic cycling type capable of producing a half sine shock pulse at the acceleration level and duration specified. The acceleration and shock pulse duration is to be measured by a piezoelectric accelerometer mounted on the test machine platform on an axis parallel to the axis of motion.

21.5 The test sample is to be mounted so that the center of gravity of the sample is as close as possible to the geometric center of the machine platform.

22 Salt Spray Corrosion Test

22.1 All metallic parts of a lighting fixture shall be resistant to corrosion and shall not interfere with the operation of a fixture when tested as described in 22.2.

Exception: Metals known to provide inherent resistance to corrosion need not be tested (see Corrosion Protection, Section 7).

22.2 The sample is to be supported vertically and exposed to salt spray (fog) as specified by the Test Method for Salt Spray (Fog) Testing, ASTM B117-1973.

22.3 The duration of the test shall be 96 hours for inside type fixtures and 200 hours for outside type fixtures.

22.4 Following the exposure, the fixture is to be examined for signs for structural degradation as a result of corrosion. The fixture is then to be turned on and off 100 times with the input voltage maintained at 110 percent of the rated voltage. A fixture intended to be ignition protected is then to be turned on for 4 hours and then subjected to the Ignition Protection Test, Section 23.

23 Ignition Protection Test

23.1 A fixture intended to be installed in an area where ignition protection is required (such as an engine compartment) shall comply with the requirements for ignition protection in accordance with the Standard for Ignition Protection Test for Marine Products, UL 1500, after having been subjected to the Vibration and Shock Tests, Sections 20 and 21 (see 22.4 and 32.6).

24 Cold Temperature Test

24.1 There shall be no damage to the fixture that may result in a risk of fire or electric shock after the conditioning described in 24.2 – 24.5.

24.2 A complete sample is to be used for this test. The sample is to be mounted to simulate a normal installation, in a test fixture, constructed to enable the assembly to be clamped to the shock table within 30 seconds after removal from the test chamber and subjected to the Shock Test as described in 24.5.

24.3 The complete assembly is to be placed in the cold chamber, which is to be set at minus 30 ±3°C (minus 22 ±5.4°F) for 24 hours. It is not necessary that the lighting fixture be operated while in the cold chamber.

24.4 At the end of the cold conditioning, prior to removal from the chamber, any external wiring subject to flexing in service is to be wrapped 360 degrees around a mandrel, first in one direction, and then the other, within 4 seconds. The mandrel diameter for wire sizes are specified in Table 24.1.

Table 24.1
Mandrel diameter

Wire size		Mandrel diameter	
AWG	(mm^2)	Inches	(mm)
16	(1.3)	1	(25.4)
14	(2.1)	1	(25.4)
12	(3.3)	2	(50.8)
10	(5.3)	2.5	(63.5)

24.5 Within 30 seconds of its removal from the cold chamber, the test fixture is to be clamped to the shock table and subjected to 25 vertical impacts of 10 g acceleration (98 m/s^2) having the duration specified in 21.3.

Exception: Fixtures marked in accordance with 32.7 need not comply with this requirement.

25 Watertightness Test

25.1 A fixture marked ″Watertight ″ is to be tested in accordance with 25.2. There shall be no accumulation of water that could interfere with the operation of the device.

25.2 The fixture is to be installed in accordance with the manufacturer's instructions. A solid stream of water from a nozzle 1 inch (25.4 mm) in diameter, at a flow rate of 65 gallons per minute (246 lpm) measured at the nozzle, is to be directed at the enclosure in all directions from a distance of 10 feet (3.1 m) for 5 minutes.

25.3 Any water on the exterior of the enclosure is to be removed with a cloth and the enclosure then opened and examined for any evidence of leakage and water accumulation.

25.4 A fixture that complies with this test shall be marked ″Outside Type – Watertight″ in accordance with 32.3.

26 Dripproof Test

26.1 A fixture marked ″ Inside Type – Dripproof″ shall show no interference with the operation of the fixture when tested in accordance with 26.2. A fixture marked ″Outside Type – Watertight″ complies with this requirement and need not be subjected to the Dripproof Test.

26.2 A fixture is to be mounted beneath a drip pan that produces both splashing and dripping and extends beyond all exposed sides of the enclosure. The bottom of the drip pan is to be equipped with uniformly distributed spouts; one spout for each 20 square inches (129 cm^2) of pan area. Each spout is to drip water at a rate of 20 drops per minute. The enclosure, while being rotated from 0 – 15 degrees downward from the vertical, is to be subjected to continuously dripping water for 30 minutes.

26.3 A fixture that complies with this test shall be marked ″Inside Type – Dripproof″ in accordance with 32.4.

PERFORMANCE – ELECTRICAL

27 Current Input Test

27.1 Input current is to be measured with the fixture operating as intended and connected to a supply circuit of rated voltage. The potential of the supply circuit is to be in accordance with Table 27.1, and the temperatures specified in Table 28.1 shall not be exceeded.

Table 27.1
DC test potential (volts) to be applied

Nominal circuit voltage rating	Voltage during Input and Temperature Test	Voltage during Abnormal Operation Test
12	14	15.50
24	28	31.00
32	40	41.25
36	42	46.50

28 Temperature Test (Surface Mounted Fixtures)

28.1 The test fixture, with lamp(s), is to be mounted to the test panel illustrated in Figure 28.1. The maximum temperature as specified in Table 28.1 shall not be exceeded. Maximum temperatures are based on an assumed ambient temperature of 30°C (86°F) (see 28.6). Any lampholder that can be moved is to be adjusted to the most adverse position regarding proximity to the enclosure and other parts of the fixture. The fixture is to be connected to the applicable supply voltage adjusted to the value specified in Table 27.1. The fixture is to be fitted with the number and type of lamps having the maximum recommended wattage as marked according to 32.1.

28.2 A fixture is to be tested with the test panel oriented either vertically or horizontally to achieve the more severe operating condition.

Exception No. 1: A fixture marked in accordance with 32.10 is to be tested as marked; that is, with the test panel oriented horizontally for a ceiling mounted fixture, or vertically for a wall mounted fixture.

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

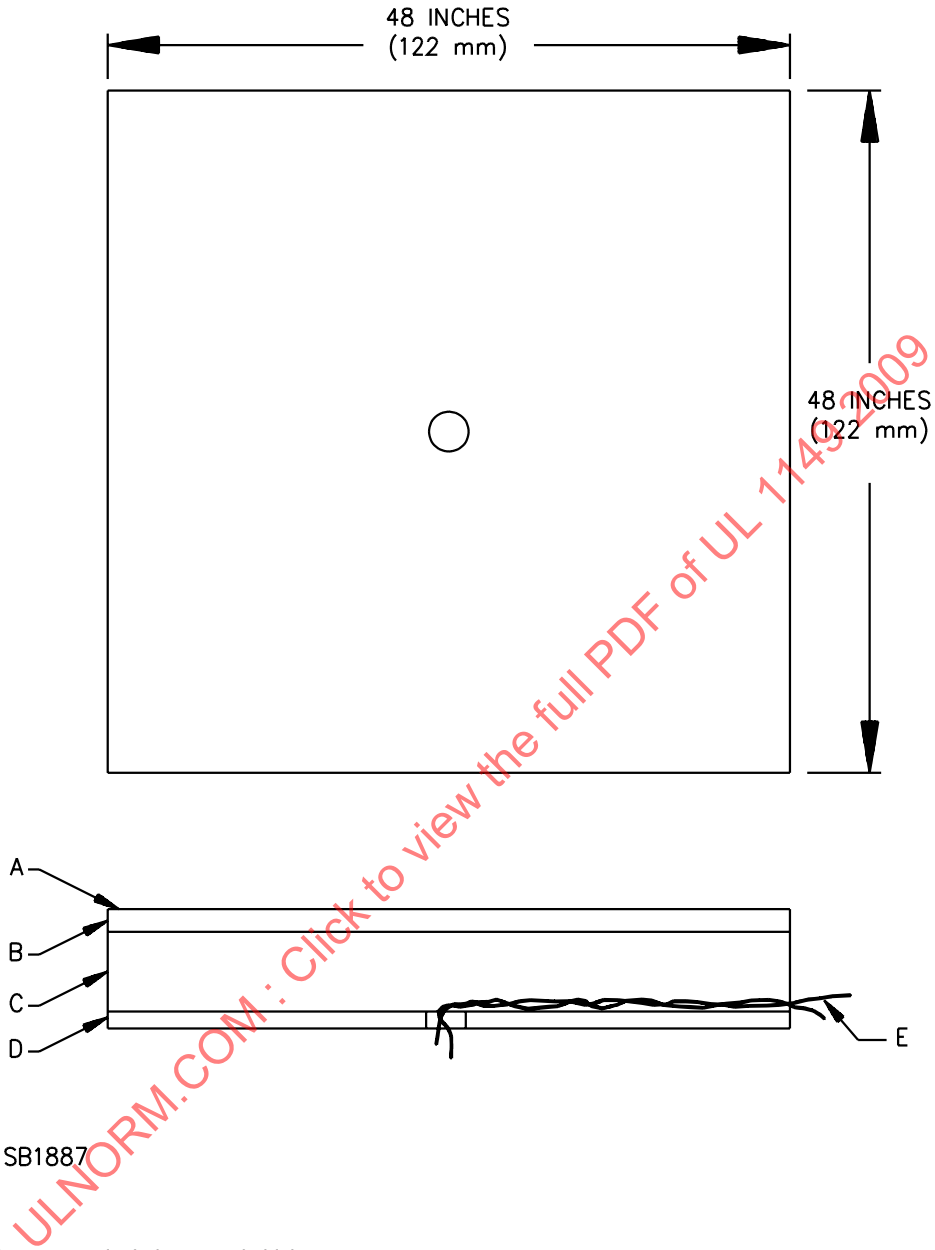
28.3 The fixture is to be operated until temperatures are constant at critical locations on the fixture and mounting surface. Thermocouple readings are considered constant when no change is recorded in three successive readings taken at 10 minute intervals.

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 are to be placed on the anticipated hottest accessible locations.

28.5 A thermocouple is to consist of wires no larger than 24 AWG (0.21 mm^2) and no smaller than 30 AWG (0.05 mm^2). It is common practice to employ 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 as specified in the Initial Calibration Tolerances for Thermocouples Table in Temperature Measurement Thermocouples, ANSI/ISA MC96.1.

28.6 The maximum acceptable temperatures for commonly used materials are as specified in Table 28.1, and are based on an assumed ambient temperature of 60°C (140°F) for fixtures specifically intended for use in machinery, engine compartment spaces or the like, or 30°C (86°F) for all other fixtures.

Figure 28.1
Test panel



A – Aluminum sheet 0.020 inch (0.51 mm) thick.

B – Air space 0.5 inch (12.7 mm).

C – Fiberglass thermal insulation 2 inches (50.8 mm) thick.

D – Vinyl faced (one side) mineral and fiberboard 0.25 inch (6.4 mm) thick.

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

Table 28.1
Maximum acceptable temperatures

Material	°C	°F
1. Varnished cloth insulation	85	185
2. Fiber employed as electrical insulation or a barrier (such as lampholder center contact insulator)	90[a]	194
3. Wood and other cellulosic material	90	194
4. Supply leads measured 0.25 inch (6.4 mm) from supply connection inside fixture	b	b
5. At any area likely to be contacted by field wiring	90[c]	194[c]
6. On a surface upon which a fixture may be mounted during service and surfaces that may be adjacent to the fixture when it is mounted	90	194
7. Phenolic composition employed as electrical insulation or as part of a component or construction, the deterioration of which would result in a risk of fire or electric shock:		
Molded composition	150[a]	302[a]
Laminated composition	126[a]	257[a]
8. Transformer with Class 105 insulation system:		
Thermocouple method	115	271
Resistance method	125	289
9. Sealing compound	d	d

[a] These limitations do not apply to compounds or components that are rated for a higher temperature.

[b] Shall not exceed marked temperature rating of the insulation of the pigtail leads.

[c] If the temperature rise exceeds 35°C (63°F) with an assumed ambient of 25°C (77°F), the marking described in 32.11 shall be provide.

[d] Unless the material is thermosetting the maximum sealing compound temperature is 15°C (27°F) less than the softening point of the compound as determined by the Test for Softening Point by Ring and Ball Apparatus, ASTM E28-67.

29 Temperature Test (Recessed Fixtures)

29.1 A recessed mounted fixture is to be mounted in its intended manner in a rectangular test box constructed of 0.5 inch (12.7 mm) thick plywood, having a removable top and dimensions such that each side is 8.5 inches (0.216 m) from the nearest point of the recessed housing.

29.2 Cellulosic insulation rated for a thermal resistance of 3.75 – 3.85 R/inch (0.148 – 0.152 R/mm) with a conditioned density of 2.0 – 2.5 pounds per cubic foot (32 – 40 kg/m^3) is to be used.

29.3 The insulation is to be conditioned through a blowing or vacuum machine before being placed around the sample fixture. The conditioned insulation may either be blown and allowed to fall into the box around the sample fixture, or blown into a storage container and placed around the sample fixture by hand or scoop so that it is free from large air pockets and packing and settling are minimized. The top is then to be secured to the test box.

29.4 The test is to be conducted in accordance with Temperature Test (Surface Mounted Fixtures), Sections 28, and Abnormal Operation Test, Section 30. The results are considered acceptable if the temperatures are within the limits specified in Table 28.1, and no temperatures obtained on the enclosure in contact with the insulation exceed 90°C (194°F).

30 Abnormal Operation Test

30.1 The Temperature Test described in 28.1 – 28.7 is to be repeated with the supply voltage adjusted to the abnormal operation value specified in Table 27.1 for no less than 5 hours and no more than 7 hours. There shall be no distortion resulting in movement of a lamp or lampholder, no distortion of any material forming part of the enclosure, and no other adverse condition as a result of the increased potential.

31 Dielectric Voltage Withstand Test

31.1 The electrical insulation of energized parts of the fixture shall be capable of withstanding for 1 minute a 500 volt DC potential between energized parts and any non current carrying parts of the assembly, without breakdown.

31.2 Where the device uses an inverter circuit to convert low voltage DC to higher voltage AC for operation of the light circuit, the AC circuit is also to be tested by applying the test voltage at the output of the inverter circuit.

MARKING

32 General

32.1 Each fixture shall be permanently and legibly marked with the following information:

a) Manufacturer's or private labeler's name or identifying symbol (may be abbreviated);

b) Model, type, or catalog designation;

c) Month and year of manufacture (may be in code);

d) Electrical rating in volts, watts, and amperes; and

e) ″Marine Type Low Voltage Fixture″.

Pressure sensitive labels secured by adhesive shall comply with the Standard for Marking and Labeling Systems, UL 969.

32.2 If a manufacturer produces a fixture at more than one factory, each such fixture shall have a distinctive marking to identify it as the product of a particular factory.

32.3 A fixture that complies with the requirements in the Watertightness Test, Section 25, shall be marked ″Outside Type – Watertight.″

32.4 A fixture that complies with the requirements in the Dripproof Test, Section 26, shall be marked ″Inside Type – Dripproof.″

32.5 A fixture not marked in accordance with 32.3 or 32.4 shall be marked ″Inside Type.″

32.6 A fixture complying with 28.7 and the ignition protection requirements specified in the Ignition Protection Test, Section 23, shall be marked ″Ignition Protected″, or the equivalent.

32.7 A fixture that does not comply with the Vibration and Shock Tests shall be permanently marked with the following or the equivalent: ″For Use Only on Vessels Over 65 Feet (20 Meters) in Length.″ The marking shall be readily visible after installation.

32.8 Input connections (terminals or pigtail leads) shall be identified where circuit polarity is a factor.

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

32.10 A fixture tested in accordance with Exception No. 1 of 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, indelibly stamped lettering, or on a self adhesive label that complies with the permanence considerations specified in 32.1. The lettering shall be at least 0.125 inch (3.2 mm) high.

32.11 If any point on a fixture attains a temperature rise of more than 35°C (63°F), and if that point may be contacted by supply wiring, the fixture shall be marked as follows:

a) For a fixture without supply leads – ″For supply connections use No. ____ AWG wires rated for at least ____°C (____°F) in which the blanks shall be the appropriate AWG No. and the temperatures specified in Table 32.1, respectively; or

b) For a recessed fixture with supply leads – The word ″CAUTION″ and the following or the equivalent: ″Risk of fire. Route field wiring away from fixture.″

32.12 A fixture with a tungsten halogen lamp shall be marked with the word ″CAUTION″ and the following or the equivalent: ″TO REDUCE THE RISK OF A BURN DURING RELAMPING, DISCONNECT POWER TO THE FIXTURE BY TURNING OFF THE (FIXTURE) (WALL) SWITCH BEFORE RELAMPING.″ Either word in parentheses is to be used as appropriate.

Exception: A fixture with a single ended tungsten halogen lamp having an integral outer glass envelope or an integral reflector (for example, an MR16 lamp) need not be provided with this marking.

32.13 If a switch is provided on a fixture and the marking specified in 32.12 requires that the power be turned off at the fixture switch, the fixture shall be marked to identify the off position of the switch. The marking shall be located adjacent to the switch. The marking shall clearly identify the position the switch actuator must be in to disconnect the ungrounded supply connection to all lampholders.

Table 32.1
Temperature markings

Rise[a]	Scale[b]	Temperature attained at a point that may be contacted by supply wiring marked temperature
36 – 50°C (97 – 122°F)	61 – 75°C (141 –167°F)	75°C (167°F)
51 – 60°C (123 – 140°F)	76 – 85°C (168 – 185°F)	85°C (185°F)
61 – 65°C (141 – 149°F)	86 – 90°C (186 – 194°F)	90°C (194°F)

[a] From Table 28.1, item 5.
[b] Obtained by adding rise temperature and 25°C.

32.14 A fixture with a single ended tungsten halogen lamp that complies with the exception to 35.1.1 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 fixtures.″

INSTALLATION AND OPERATING INSTRUCTIONS

33 General

33.1 With each fixture and associated accessories, the manufacturer shall provide instructions and specifications that provide for proper installation in accordance with the National Fire Protection Association and all applicable Standards of the American Boat and Yacht Council, Inc. A fixture that does not comply with the ignition protection requirements specified in the Ignition Protection Test, Section 23, and that is provided with a switch, shall include the wording in the instructions ″CAUTION″ and the following or the equivalent: ″Potential Ignition Source. Do not Install In Areas Requiring Ignition Protection.″

33.2 If a fixture can emit electrical interference (due to a ballast, inverter, or the like) that can cause problems with radio transmission or reception aboard a vessel, the instructions shall include the statement: ″WARNING″ and the following or equivalent ″This light may cause interference with radio. Turn light off if distortion is detected.″

PART II – TUNGSTEN HALOGEN LAMP FIXTURES

CONSTRUCTION

34 General

34.1 In addition to the construction requirements for all fixtures, as applicable, a tungsten halogen fixture shall comply with the requirements specified in 35.1.1 – 35.1.4 and 36.1.

35 Lamp Containment Barrier

35.1 General

35.1.1 A fixture with a tungsten halogen lamp shall be provided with a lamp containment barrier that consists of a top, sides, and bottom that enclose the lamp compartment. The barrier may consist of a metal housing (recessed or otherwise), a glass diffuser or lens, a metal canopy, a metal screen, or the like (see 35.1.2 – 35.1.4). The lamp containment barrier shall limit the emission of quartz particles in accordance with 35.1.2.

Exception: A fixture intended for use with a single ended tungsten halogen lamp with an integral outer envelope or a non pressurized 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 fixture is marked in accordance with 32.14.

35.1.2 A lamp containment barrier shall not have any open holes greater than 0.125 inch (3.2 mm) diagonally or in diameter.

Exception: A lamp containment barrier may have open holes greater than 0.125 inch diagonally or in diameter if the holes are not line of sight openings between the lamp and any points outside the fixture.

35.1.3 A lamp containment barrier shall be constructed of:

a) Metal;

b) Heat resistant glass such as tempered, annealed, or borosilicate glass;

c) Porcelain; or

d) Ceramic.

The barrier shall be at least 0.016 inch (0.41 mm) thick if of metal, and 0.125 inch (3.2 mm) thick if of glass (3.0 mm for metric trade size glass). However, a lamp containment barrier constructed of an equivalent material, as determined by investigation, may be used.

35.1.4 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.

PERFORMANCE

36 General

36.1 A tungsten halogen lamp shall comply with the mechanical performance requirements for all fixtures, as well as 27.1 and 37.1.

37 Temperature Test

37.1 A fixture with a tungsten halogen lamp is to be subjected to the Temperature Test, Sections 28 or 29, as appropriate, and Abnormal Operation Test, Section 30. During the Temperature Test on a surface mounted fixture, the maximum temperature of a ceiling or wall surface that is subject to receiving the radiant energy of a tungsten halogen lamp shall comply with Table 28.1. The temperatures are to be measured by thermocouples secured to the ceiling and adjacent surfaces by a single layer of masking tape over the thermocouple bead.

PART III – FLUORESCENT FIXTURES

GENERAL

38 Scope

38.1 These requirements apply to low voltage fluorescent lighting fixtures. They do not apply to incandescent fixtures.

38.2 A low voltage fluorescent fixture shall comply with the applicable requirements in Part I supplemented by, and in some cases amended by, the construction requirements for fluorescent fixtures.

CONSTRUCTION

39 Frame and Enclosure

39.1 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 no more than 42.4 volts peak, or one in which the actual current would be no 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 of the Standard for Fluorescent Lamp Starters, UL 542, need not be so located or enclosed.

39.2 A polymeric material used to enclose a live part as described in 39.1 shall comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

40 Printed Wiring Boards

40.1 A printed wiring board or printed wiring assembly provided as part of equipment shall comply with 40.2 – 40.4.

40.2 A printed wiring board shall have a minimum flammability rating of HB when tested in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

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

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

41 Spacings

41.1 Each spacing between live parts of opposite polarity and between live and dead metal parts shall be not less than those indicated in Table 41.1.

Exception: The spacing on a printed wiring assembly may be as specified in 41.3.

41.2 The spacing between uninsulated live parts of different circuits involving different voltages shall not be less than that required for the circuit of the higher voltage.

41.3 The spacing on a printed wiring board assembly may be less than that specified in Table 41.1 if a conformal coating and a spacing are used in compliance with the requirements described in Table 41.2.

Table 41.1
Spacings

Spacing involved		Minimum spacing	
		0 – 50 volts rms[a]	51 – 150 volts rms[a]
Uninsulated live parts of opposite polarity	Through air	1/16 inch (1.6 mm)	1/8 inch (3.2 mm)
	Over surface	1/16 inch (1.6 mm)	1/4 inch (6.4 mm)
Between uninsulated live parts and uninsulated grounded dead metal parts other than the enclosure, or exposed, dead metal parts that are isolated (insulated)	Through air	1/16 inch (1.6 mm)	1/8 inch (3.2 mm)
	Over surface	1/16 inch (1.6 mm)	1/4 inch (6.4 mm)
Wall of metal enclosure, including fittings for conduit or armored cable[b]	Through air	1/4 inch (6.4 mm)	1/2 inch (12.7 mm)
	Over surface	1/4 inch (6.4 mm)	1/2 inch (12.7 mm)

[a] For peak voltages, multiply applicable rms voltage by $\sqrt{2}$.

[b] A metal piece attached to a metal enclosure is considered to be a part of the enclosure if deformation of the enclosure is likely to reduce spacings.