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By the Authority Vested By Part 5 of the United States Code § 552(a) and Part 1 of the Code of Regulations § 51 the attached document has been duly INCORPORATED BY REFERENCE and shall be considered legally binding upon all citizens and residents of the United States of America. *HEED THIS NOTICE*: Criminal penalties may apply for noncompliance.

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APPROVED

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THE EXECUTIVE DIRECTOR
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WASHINGTON, D.C.

UL 1104

STANDARD for SAFETY

MARINE NAVIGATION LIGHTS

UNDERWRITERS LABORATORIES INC.®

UNDERWRITERS LABORATORIES INC.®

an independent, not-for-profit organization testing for public safety

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October 20, 1986

Revision pages for

STANDARD FOR

MARINE NAVIGATION LIGHTS

UL 1104, FIRST EDITION

Attached is a revision of the first edition of UL 1104.

A CHANGE IN REQUIREMENTS IS INDICATED BY A VERTICAL LINE IN THE MARGIN ON PAGES DATED OCTOBER 20, 1986. EDITORIAL CHANGES ARE NOT SO MARKED.

THESE NEW AND REVISED REQUIREMENTS ARE NOW IN EFFECT EXCEPT FOR THOSE PARAGRAPHS, SECTIONS, TABLES, AND FIGURES WHICH BECOME EFFECTIVE MAY 1, 1988, AS INDICATED IN THE SMALL PRINT NOTE FOLLOWING THE AFFECTED ITEM. TO RETAIN THE REQUIREMENTS IN EFFECT UNTIL MAY 1, 1988 DO NOT DISCARD THE PREVIOUS PAGES REPLACED BY THOSE HAVING FUTURE EFFECTIVE DATES UNTIL THIS DATE.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this standard unless the applicant specifically requests that the product be judged under the current requirements. However, should the applicant elect this option, it should be notedthat compliance with all the requirements in this standard will be required as a condition of continued Classification and Follow-Up Services after the effective date and understanding of this should be signified in writing.

The new and revised requirements are substantially in accordance with UL's bulletins on this subject dated June 5, 1984 and February 11,1986. These bulletins are now obsolete and may be discarded.

Attention is directed to the note on the title page of this standard outlining the procedure to be followed to retain the approved text of ANSI/UL 1104 — 1983.

Revised and/or additional pages may be issued from time to time. With the inclusion of the accompanying material, the standard consists of pages dated as shown in the following check list:

Page	Date
1	January 12, 1984
2, 3	October 20, 1986
4	October 27, 1981
5, 6, 6A, 7, 8, 8A, 9, 10, 10A, 11, 12	October 20, 1986
13	October 27, 1981
14, 14A, 15—20, 20A, 21—27	October 20, 1986

AMERICAN NATIONAL STANDARD

UL 1104

STANDARD FOR MARINE NAVIGATION LIGHTS

FIRST EDITION

First Impression .....October 27, 1981

Approval as an American National Standard covers the numbered paragraphs on pages dated October 27, 1981. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the approved text. Revisions of this standard will be made by issuing revised or additional pages bearing their dates of issue.

Approved as ANSI/UL 1104–1983, November 18, 1983

**Replaces page 1 dated October 27, 1981*

TABLE OF CONTENTS

Part II - Navigation Lights for Use on Boats and Vessels Less Than 65 Feet in Length

**Replaces page 3 dated October 27, 1981*

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.

GENERAL

1. Scope

1.1 These requirements cover marine navigation light fixtures intended for use in accordance with the applicable U. S. Coast Guard (USCG) Regulations as specified in the International Regulations for Preventing Collisions at Sea, 1972 (72 COLREGS) and the Inland Navigation Rules, COMDTINST M16672.2A.

Paragraph 1.1 revised October 20,1986

1.2 *Paragraph 1.2 revised and relocated as paragraph 3A.2 October 20, 1986*

1.3 These requirements do not cover navigation light fixtures for use in hazardous locations as defined in the U. S. Coast Guard Electrical Engineering Regulations.

2. General

2.1 Marine navigation light fixtures shall employ materials that are acceptable for the particular use.

2.2 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. SI units are in accordance with the American National Standard for Metric Practice, ANSI/ASTM E380.

2.3 A component of a product covered by this standard shall comply with the requirements for that component, and shall be used in accordance with its recognized rating and other limitations of use. 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.

3. Glossary

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

3.2 ALL ROUND LIGHT – A light showing an unbroken light over an arc of the horizon of 360 degrees.

3.2A DESIGN VOLTAGE — The input voltage necessary for a lamp to operate at rated candlepower, or a rated wattage if rated candlepower is not specified.

Paragraph 3.2A added October 20, 1986

3.2B FIXTURE (NAVIGATION LIGHT) — The completely assembled navigation light, including the lamp, lampholder, housing, lens, and other components necessary for the light to function as intended.

Paragraph 3.2B added October 20, 1986

3.3 FLASHING LIGHT – A light flashing at regular intervals at a frequency of 120 flashes or more per minute.

3.3A LAMP — That component of a navigation light that produces light when energized.

Paragraph 3.3A added October 20, 1986

3.3B LAMPHOLDER — That component of a navigation light that supports the lamp in the operating position and provides the electrical connections to the lamp.

Paragraph 3.3B added October 20, 1986

3.4 MASTHEAD LIGHT – A white light placed over the fore and aft center line of the vessel, showing an unbroken light over an arc of the horizon of 225 degrees, and fixed to show the light from right ahead to 22.5 degrees abaft the beam on either side of the vessel.

3.4A NOMINAL SYSTEM VOLTAGES:

A. For alternating-current systems — 110, 115, 120, 220, 230, and 240 volts.

B. For direct-current systems — 12, 24, 32, and 120 volts.

Paragraph 3.4A added October 20,1986

3.5 PREFOCUS LAMP BASE – A light bulb whose filament(s) is (are) precisely positioned with respect to its lampholder.

3.6 SIDELIGHTS – A green light on the starboard side and a red light on the port side, each showing an unbroken light over an arc of the horizon of 112.5 degrees and fixed to show the light from right ahead to 22.5 degrees abaft the beam on its respective side.

3.7 STERN LIGHT – A white light placed as nearly as practicable at the stern, showing an unbroken light over an arc of the horizon of 135 degrees, and fixed to show the light 67.5 degrees from right aft on each side of the vessel.

3.8 TOWING LIGHT – A yellow light having the same characteristics as the stern light.

3.9 WATERTIGHT FIXTURE – An enclosed navigation light constructed to prevent water from entering any part of the housing that contains wiring devices, wiring or lamps, under any condition of exposure other than submersion.

PART I — NAVIGATION LIGHTS FOR USE ON VESSELS 65 FEET OR MORE IN LENGTH

GENERAL

3A. Scope

3A.1 The requirements of Sections 4-33 apply to navigation lights intended for use on vessels 65 feet (20 m) or more in length.

Paragraph 3A.1 added October 20, 1986

3A.2 A navigation light complying with these requirements of Sections 4-20, 22-33, 42, 43, and 46 may also be used on vessels or boats subject to the Federal Boat Safety Act of 1971.

Paragraph 1.2 revised and relocated as paragraph 3A.2 October 20, 1986

CONSTRUCTION — MECHANICAL

4. General

4.1 The enclosure of a navigation light shall completely house all current-carrying parts, lamps, and lamp adjustments so that the components will maintain a fixed relationship when the navigation light is subjected to vibration and motion in service.

4.2 All edges, projections, and corners of the enclosure shall be smooth and rounded and not sufficiently sharp to constitute a risk of injury to persons during intended use and maintenance of the navigation light.

4.3 Whenever referee measurements are necessary to determine that a part as described in paragraph 4.2 is not sufficiently sharp to constitute a risk of injury to persons, the method described in the requirements for determination of sharpness of edges on equipment, UL 1439, is to be employed.

4.4 The enclosure shall be of a watertight construction. See Watertight Thermal Shock Test, Section 24.

4.5 A wiring compartment, such as one used for field wiring, shall have no sharp edges, exposed edge of screws, or the like, which may abrade, cut, or otherwise damage the insulation of electrical conductors.

4.6 A screw fastener shall be locked by solder, a setscrew, sealing, or equivalent means.

4.7 A machine screw shall engage no fewer than two full threads in a securing nut or a tapped hole.

5. Enclosure

5.1 The frame and enclosure shall be sufficiently strong and rigid to resist the abuses likely to be encountered during intended installation and use. The degree of resistance inherent in the unit shall preclude total or partial collapse and subsequent reduction of spacings, loosening or displacement of parts, and other malfunctions that alone or in combination will affect their arcs of visibility or the watertight construction. See paragraphs 5.3–5.5, and Table 5.1 for metal enclosure requirements, and paragraphs 5.6 and 5.7 for nonmetallic enclosure requirements.

5.2 The enclosure or enclosure part shall reduce the risk of electric shock, and shall not create or contribute to a risk of fire, electric shock, or injury to persons.

TABLE 5.1
ALUMINUM ALLOYS

Sand-Cast	Permanent-Mold Cast	Die-Cast	Machined Bar and Rod Stock
G4A	GM70B	G8A	5052
G10A	GS42A	GS31A	5053
GM70B	S5A	S5C	5056
GS42A	S5B	S12A	5456
S5A	SG70A	S12B	6061
S5B	SG70B	SG100A	5086
SG70A	SG71A	SG100B	
SG70B			
SG71A			
ZG61B			

5.3 An overall metallic enclosure of a navigation light shall be formed of (1) a sheet or plate aluminum alloy of the 5000 series as given in the Standard Specification for Aluminum-Alloy Sheet and Plate, ANSI/ASTM B209—80; (2) an aluminum alloy described in Table 5.1; or (3) a corrosion-resistant alloy or a metal alloy with a corrosion-resistant finish having resistance to corrosion equivalent to the metals in item (1) or (2) when tested as described in the Salt Spray Corrosion Test, Section 23. See paragraphs 5.4 and 5.5 for acceptable metals.

5.4 Silver, copper, brass with less than 35 percent zinc, bronze, corrosion-resistant steel, stainless steel of the 300 series, certain nickel-copper alloys, aluminum-base alloys with a copper content of 0.2 percent or less, copper silicon, and steel with a hot-dipped galvanized finish, are acceptable without the addition of a corrosion-resistant finish.

5.5 Metals other than those specified in paragraph 5.4 are acceptable if the metal alloys and combinations comply with the requirements of the Salt Spray Corrosion Test, Section 23.

5.6 A nonmetallic enclosure, or enclosure part, shall have mechanical strength and durability and be formed so that operating parts will be protected against damage and the enclosure will be resistant to the abuses likely to be encountered during installation, intended use, and service. In any case, the mechanical strength shall be at least equivalent to a 0.032-inch (0.81-mm) thick sheet brass enclosure.

Paragraph 5.6 revised October 20, 1986

†*Additional page*

5.7 Among the factors that are to be taken into consideration when judging the acceptability of a nonmetallic enclosure or frame are:

A. Mechanical strength.

B. Resistance to impact.

C. Moisture absorptive properties of parts in contact with energized components; see Exposure to Humid Atmosphere Test, Section 27.

D. The flammability of the material; the material shall be classified 94V-0 in accordance with the requirements for tests for flammability of plastic materials for parts in devices and appliances, UL 94.

E. Resistance to arcing.

F. Resistance to temperatures to which the material might be subjected under all anticipated conditions of use; see Watertight Thermal Shock Test, Section 24, and Temperature Test, Section 25, as applicable.

G. Aging characteristics.

H. Resistance to sunlight (ultraviolet radiation) as determined by the Light and Water Test, Section 26.

6. Means for Mounting

6.1 The means for mounting shall be arranged and constructed so that the navigation light can be secured to the vessel in a manner that will maintain the vertical and horizontal arcs of visibility specified in the Performance section of this standard.

6.2 Arms and supports, if fastened to the enclosure, shall provide strength and rigidity and shall prevent turning or changes in the position of the lamp(s) or light source, and movement of wires or wiring devices after installation.

7. Servicing and Installation

7.1 Provision shall be made for the replacement or servicing of lamps or other light sources while at sea. The servicing provisions shall be constructed and arranged so that the assembly will retain its watertight integrity (see Watertight Thermal Shock Test, Section 24), and the arcs of visibility (see Visibility Test, Section 20) will not be altered by the servicing operations.

7.2 If it is necessary to remove the lamp socket to make field connections, the method of mounting shall maintain intended alignment or the socket and mounting means shall be marked to permit intended alignment. If the method of mounting cannot maintain alignment, the socket shall be installed and sealed in position and the method of wiring shall be so that it is not necessary to remove the socket.

7.3 If the cut-off angles of a navigation light depend on the installation of removable shields, the method of mounting the shields shall maintain intended alignment of the cut-off angles or the shield and navigation light fixture shall be marked with permanent alignment marks.

7.4 If the navigation light requires the installation of external screens to attain the intended cut-off angles, the manufacturer shall provide construction prints, templates and other information as necessary so that the lights in the field will comply with the cut-off angle requirements during intended installation and operation.

8. Lenses and Globes

8.1 Lenses and globes shall be of an impact-resistant glass or plastic capable of withstanding thermal shock, temperatures between minus 30°C and 60°C, and exposure to sunlight and salt atmosphere without cracking, crazing or degradation of the color of the lens or globes. See Watertight Thermal Shock Test, Section 24; Temperature Test, Section 25; and Light and Water Test, Section 26.

8.2 A lens or globe shall have permanent chromaticity characteristics so that the color characteristics of the light outside the lens or globe will fall within the corner coordinates of the International Commission of Illumination (CIE) diagram specified for each color (see Table 8.1). See the International Regulations for Preventing Collisions at Sea, 1972 (72 COLREGS) — and the Inland Navigation Rules, as contained in COMDTINST M16672.2A. Chromaticity shall be determined in accordance with the requirements of paragraph 8.3.

Paragraph 8.2 revised October 20, 1986

Replaces page 7 dated October 27, 1981

TABLE 8.1
CORNER COORDINATES FOR COLOR SPECIFICATION

161.007–9 (b) White					
X = 0.525	0.525	0.452	0.310	0.310	0.443
Y = 0.382	0.440	0.440	0.348	0.283	0.382
161.007–9 (c) Green					
X = 0.028	0.009	0.300	0.203		
Y = 0.385	0.723	0.511	0.356		
161.007–9 (d) Red					
X = 0.680	0.660	0.735	0.721		
Y = 0.320	0.320	0.265	0.259		
161.007–9 (e) Yellow					
X = 0.612	0.618	0.575	0.575		
Y = 0.382	0.382	0.425	0.406		

8.3 The chromaticity of the lens or globes is to be determined by colorimetric testing as described in the Practice for Spectrophotometry and Description of Color in CIE 1931 System, ANSI/ASTM E308–66, or Color Specification for Electric Signal Lighting Devices, SAE J578d–1978. Other methods providing results equivalent to either of these two methods may be used if agreeable to all parties concerned. A spectral plot of the light-lens combination is to be made.

9. Gaskets and Bushings

9.1 A gasket or bushing that forms part of a watertight enclosure shall be acceptable for the purpose with respect to (1) proximity to live parts, (2) water absorption, (3) conductivity, (4) temperature and rain resistance, and (5) resistant to ultraviolet light. See Light and Water Test, Section 26.

Paragraph 9.1 revised October 20, 1986

9.2 A gasket or bushing that may contact or come within 1/8 inch (3.2 mm) of any live part or wiring shall be made of a material that will not become conductive when it is exposed to moisture. To determine compliance with this requirement, a gasket shall comply with the requirements in Section 27A.

Paragraph 9.2 revised October 20, 1986

9.3 *Paragraph 9.3 deleted October 20, 1986*

9.4 A gasket shall not crack if flexed 45 degrees after being conditioned at minus 22±2°C for 24 hours.

CONSTRUCTION — ELECTRICAL

10. General

10.1 The navigation light shall employ materials acceptable for the highest voltage and wattage for which it is marked as required in paragraph 33.1.

10.2 No overcurrent protection device shall be provided as an integral part of the fixture.

10.3 The porcelain part of a lampholder shall not be rigidly mounted. The mounting shall allow for thermal expansion and contraction, vibration, and other operating stresses as determined by the performance tests of this standard.

10.4 Electrical components shall be securely mounted and shall be prevented from turning.

10.5 The means for preventing turning is to consist of more than friction between surfaces. Constructions that comply with this requirement include a toothed lock washer with spring takeup, or a locknut sealed against another nut, or other equivalent means.

Paragraph 10.5 revised October 20, 1986

10.6 *Paragraph 10.6 deleted October 20, 1986*

11. Lamps

11.1 A prefocus base lamp shall be used with a lampholder that will maintain intended positioning of the lamp filament when the lamp is replaced.

11.1A The design voltage of a lamp shall be within (1) ± 10 percent of the nominal system voltage for a fixture intended for use on an ac system and (2) ± 20 percent of the nominal system voltage for a fixture intended for use on a dc system. See paragraph 19.3.

Paragraph 11.1A added October 20, 1986

11.2 The average life of the lamp (flashing or steady burning) at its design voltage shall be not less than 500 hours. See paragraph 28.1.

12. Lampholders

12.1 Aluminum shell lampholders, aluminum wire, or other aluminum electrical components shall not be used. Steel lampholders may be employed if the lampholder complies with the requirements of the Salt Spray Corrosion Test, Section 23.

12.2 The minimum depth of the lamp cavity of a screw-shell lampholder, as measured vertically from the plane of the depressed center contact to the plane of the rim of the insulating lining or lampholder body (if of insulating material), shall be as indicated in Table 12.1.

Exception: This depth limitation does not apply to a construction in which the outer shell (insulating material) is flared and extends beyond the specified limit to further reduce the risk of unintentional contact with live parts.

12.3 If the method of mounting a lampholder affects the depth of the lamp cavity, the determination of its depth is to be made with the device mounted as intended.

TABLE 12.1
DEPTH OF LAMP CAVITY

	Depth of Lamp Cavity, Inches (mm)	
Type of Lampholder	Minimum	Maximum
Mogul	1-5/8 (41.3)	1-11/16 (42.9)
Medium	15/16 (23.8)	1 (25.4)
Intermediate	25/32 (19.8)	27/32 (21.4)
Candelabra	5/8 (15.9)	11/16 (17.5)
Miniature	15/32 (11.9)	17/32 (13.5)

13. Wiring

13.1 All internal wiring shall consist of stranded copper conductors and shall not be exposed to damage. Wiring shall have insulation rated for the potentials and temperatures to which it may be subjected. Internal wiring shall be routed or secured to prevent interference with the optical performance of the light and to reduce the likelihood of malfunction of the wiring and connections. Wire or cords as tabulated in Tables 13.1 and 13.2, or the equivalent, shall be used.

Exception: Short internal wires secured at both ends and not subject to flexing may be solid conductors.

Paragraph 13.1 revised October 20, 1986

13.2 Internal wiring shall be secured by means of a wire binding screw, stud terminal, setscrew, or wire clamp, in a manner that permits no loose strands of wire. Compliance may be accomplished by any of the following:

A. The use of a pressure terminal connector: of the ring or captive-spade type or a crimped eyelet.

B. Mechanically securing and then soldering the wire ends, soldering and then securing the end with a setscrew, or soldering and forming the end into a loop and then securing the end with a wire-binding screw or terminal stud nut; provided that the wire is mechanically clamped within 1 inch (25 mm) of the connection to reduce the likelihood of movement, flexing, and vibration of the wire at the connection. The wire shall not be secured by a setscrew that bears directly against the loose strands.

C. By twisting all strands together and securing the end with a cupped washer that will retain the strands. A twist-on connector (wire nut) shall not be used.

D. Equivalent means.

Revised paragraph 13.2 effective May 1, 1988

13.3 Internal conductors shall be acceptable for the application, and of a size determined by the ampacity of the navigation light as indicated in Table 13.2.

13.4 A navigation light shall be constructed so that wires can be pulled through, or the light otherwise wired, without damage to the insulation of the conductors. See paragraph 4.5.

TABLE 13.1
TEMPERATURE AND VOLTAGE RATINGS
OF WIRES AND CORDS

Maximum Temperature[a]	Maximum Potential and Types of Wire Cord		
	300 Volts	600 Volts	1000 Volts
60°C	SJ, SJE, SJO, SJT, SJTO, SJTOO	TF, TFF, S, SE, SO, SOO, ST, STO, STOO	—
75°C	—	FFH-2, RFH-2	RH-10
90°C	CF, HS[b], HSO[b], HSJ[b], HSJO[b]	—	—
150°C	AFS[c], AFSJ[c], AF	SFF-2	—
200°C	—	SF-2	—

[a]Some types are acceptable for higher temperatures, as marked on the jacket.

[b]The conductors are acceptable for not more than 90°C. The jacket is limited to 60°C for Types HSJ and HSJO and to 75°C for Types HS and HSO.

[c]The conductors are acceptable for no more than 150°C. The jacket is limited to 75°C.

Table 13.1 revised October 20, 1986

TABLE 13.2
MINIMUM ACCEPTABLE AMPACITY OF WIRES AND FLEXIBLE CORDS

	Types of Wire or Flexible Cord	Ampacity[a] 18 AWG (0.82 mm^2)	16 AWG (1.3 mm^2)	14 AWG (2.1 mm^2)	12 AWG (3.3 mm^2)	10 AWG (5.3 mm^2)
Wires	RH-10	—	—	20	25	40
Fixture Wires	SF-2	6	8	17	22	28
	SFF-2, TF, and TFF					
	FFH-2, RFH-2	5	7	—	—	—
Flexible Cords	AFS, AFSJ, HS, HSO, HSJ, HSJO	10	15	20	30	35
	S, SE, SO, SOO, SJ, SJE, SJO ST, STO, STOO, SJT, SJTO, SJTOO	7	10	15	20	25

[a]Not all the wires and cords shown are made in all of the No. 18—10 AWG (1.0—2.6mm^2 sizes. The ampacity of wire not assigned, may be considered to be the same as for Type TF fixture wire of the same AWG size.

Table 13.2 revised October 20, 1986

Replaces page 10 dated October 27, 1981

14. Supply Connections

Cord Connected

14.1 *Paragraph 14.1 deleted October 20, 1986*

14.2 Flexible cord or cable provided for making supply connections shall:

A. Be acceptable for at least hard usage (Type SJ or the equivalent) and comply with the Standard for Flexible Cord and Fixture Wire, UL 62;

B. Comply with the cable requirements in the Recommended Practice for Electrical Installations on Shipboard, IEEE 45-83; or

C. Be equivalent to the types specified in items A and B.

Paragraph 14.2 revised October 20, 1986

14.3 A strain relief shall be provided with means to prevent the mechanical stress on a factory-installed flexible cord from being transmitted to terminals, splices, or internal wiring. The strain relief means shall comply with the requirements specified in paragraphs 22.1 and 22.2.

14.4 Means shall be provided to prevent the flexible cord from being pushed into the navigation light fixture through the cord entry hole if such a displacement may subject the cord to mechanical damage, or to exposure to a temperature higher than that for which the cord is rated.

14.5 A watertight stuffing tube shall be provided at the point where a flexible cord enters the fixture.

Permanently Connected

14.6 A navigation light not provided with a factory-installed power-supply cord shall be provided with terminals for the connection of field wiring that comply with the requirements of paragraphs 13.2 and 14.7-14.10.

Exception: Internal pigtail leads that are not less than 6 inches (152 mm) long may be provided for connections to field wiring by means of pressure terminal connectors if the leads are routed and terminated in accordance with the requirements of paragraphs 13.1 and 13.2.

Paragraph 14.6 revised October 20, 1986

14.7 The terminals specified in paragraph 14.6 may be provided on a separate terminal block or may be integral with the lampholder, and shall be acceptable for the size of conductors involved. The spacings shall be as specified in Spacings, Section 17.

14.8 A wiring terminal shall be provided with an acceptable soldering lug or pressure terminal connector securely fastened in place (for example, firmly bolted or held by a screw).

Exception: A wire-binding screw may be employed at a wiring terminal intended to accommodate a No. 8 AWG (8.4 mm^2) or smaller conductor if upturned lugs or the equivalent are provided to hold the wire in position.

14.9 A wiring terminal shall be prevented from turning.

14.10 A wire-binding screw at a wiring terminal shall be not smaller than No. 10 (4.8 mm diameter) except that a No. 8 (4.1 mm diameter) screw may be used at a terminal intended only for the connection of a single No. 14 AWG (2.1 mm^2) conductor, and a No. 6 (3.5 mm diameter) screw may be used for the connection of a No. 16 or 18 AWG (1.3 or 0.82 mm^2) conductor.

14.11 A terminal plate tapped for a wire-binding screw shall be of metal not less than 0.050 inch (1.3 mm) thick and shall not engage less than two full threads in the screw, except that a plate less than 0.050 inch but not less than 0.030 inch (0.76 mm) thick is acceptable if the tapped threads have acceptable mechanical strength. If necessary, the plate may be extruded to provide the threads.

Paragraph 14.11 revised October 20, 1986

14.12 A terminal plate formed from stock having the minimum required thickness specified in paragraph 14.11 may have the metal extruded at the tapped hole to provide two full threads for the binding screw.

14.13 Upturned lugs or a cupped washer shall be capable of retaining a supply conductor of the size indicated in paragraph 14.8 under the head of the screw or washer.

14.14 A wire-binding screw shall thread into metal.

14.15 A knockout or hole provided in a fixture for the entrance of power-supply cable shall be located to facilitate connection of the supply wires to the supply connection means in the intended manner. See paragraph 14.5.

**Replaces page 11 dated October 27, 1981*

14.16 A knockout or hole provided for field connection of marine-type cable shall be surrounded by a flat surface that has a diameter not less than the outside diameter of the trade size of locknut corresponding to the knockout or hole provided and that is concentric with the knockout or hole. This dimension is at least 1-5/32 inches (29.3 mm) in diameter for the 1/2 inch trade size (21.3 mm outside diameter), 1-29/64 inches (33.6 mm) for the 3/4 inch trade size (26.7 mm outside diameter), and 1-13/16 inches (46.0 mm) for the 1-inch trade size (33.4 mm outside diameter). For cast metal, the flat area is required on the outer surface only.

14.17 If threads for the connection of marine-type cable are tapped all the way through a hole in the wall of a fixture or outlet box or if an equivalent construction is employed, there shall be not less than three nor more than five threads in the metal. If the threads for connection of marine-type cable are not tapped all the way through a hole in the wall of a fixture or outlet box, a conduit hub, or the like, there shall be not less than five full threads in the metal and there shall be a smooth, rounded inlet hole for the conductors equivalent to that provided by a standard conduit bushing. The inlet hole shall have an internal diameter approximately equal to that of the corresponding trade size of rigid metal conduit.

15. Splice Enclosures

15.1 A splice or tap shall be enclosed and shall be accessible for inspection.

Paragraph 15.1 revised October 20, 1986

15.2 With reference to paragraph 15.1, a fixture having all connections made in a junction or outlet box and having a lampholder that serves as a cover for the box or that closes the opening in the cover to the box is to be considered to have all splices acceptably enclosed.

15.3 A splice or a tap shall not be enclosed in a fixture arm or stem.

16. Splices

16.1 A splice shall be made mechanically and electrically secure and, unless an acceptable splicing device is used, shall be soldered. A soldered joint and a joint made with uninsulated pressure wire connectors (solderless connectors) shall be covered with insulation equivalent (including thickness) to that on the conductors.

16.2 A fixture-type splicing connector, unless rated for use at higher potentials, is acceptable for joining wires that involve a potential no higher than 300 volts; except that a connector acceptable for a maximum potential of 300 volts may be used to join wires operating at more than 300 volts if the splice (including the connector) is covered with insulation equivalent (including thickness) to that on the conductors.

16.3 Unless an acceptable insulated wire connector is employed, a splice or joint shall be treated as follows:

A. If not subjected to a temperature higher than 80°C, a splice or joint shall be covered with rubber tape secured in place by an outer winding of friction tape, with a combination rubber and friction tape, or with thermoplastic tape.

B. If subjected to a temperature higher than 80°C, but not higher than 90°C, a splice or joint shall be covered with mineral fiber cord or tape secured in place by an outer winding of friction tape or bonded with water glass (sodium silicate).

C. If subjected to a temperature higher than 90°C, a splice or joint shall be covered with mineral fiber cord or tape bonded with water glass.

17. Spacings

17.1 Except as noted in paragraph 17.2, the spacing between uninsulated live parts of opposite polarity and the spacing between an uninsulated live part and metal that may be grounded when a fixture is installed shall be not less than that indicated in Table 17.1.

TABLE 17.1
SPACINGS

Voltage Involved	Minimum Acceptable Spacings in Inches (mm)	
	Through Air	Over Surface
50–250	1/4 (6.4)	3/8 (9.5)
251–600	3/8 (9.5)	3/8 (9.5)
601–1000	3/8 (9.5)	1/2 (12.7)

17.2 The spacings specified in Table 17.1 do not apply between uninsulated live parts of a wiring device, such as a lampholder with integral screw terminals used for field wiring of the supply circuit, and dead metal that is part of the wiring device (including mounting screws, rivets, yoke, clamp, or the like), or between such live parts and that part of the dead metal surface of the fixture on which the device is mounted in its intended manner.

17.3 Some examples of the spacings referred to in paragraphs 17.1 and 17.2 are shown in Figure 17.1.

18. Grounding

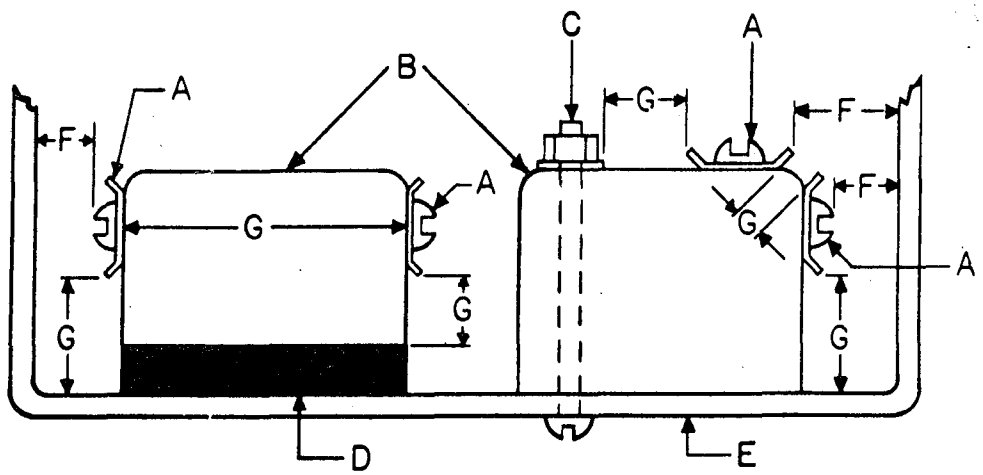
18.1 There shall be provision for grounding a metal fixture. All exposed dead metal parts, except isolated parts that do not enclose wiring, shall be in direct electrical connection with the means for grounding.

18.2 A metal part coated with vitreous enamel is not to be considered isolated and is required to be bonded in accordance with the requirement specified in paragraph 18.1.

18.3 An equipment-grounding conductor shall be not smaller than No. 18 AWG (0.82 mm^2) in size; and, if insulated, shall be identified by a green color, with or without one or more yellow stripes. No other wire intended for field connection shall be green or green and yellow. An internal bonding jumper need not be identified.

18.4 A terminal intended solely for connection of an equipment-grounding conductor shall be capable of securing a conductor of the size required for the particular application.

FIGURE 17.1
COMPONENT SPACINGS



A. Uninsulated live parts of a component.
B. Insulating material of a component.
C. Mounting screw of a component.
D. Dead metal part of a component.
E. Dead metal parts of the product.
F. Spacings to which the requirements of this standard apply unless specifically noted otherwise.
G. Spacings to which the requirements of this standard do not apply.

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18.5 The surface of an insulated lead intended solely for the connection of an equipment-grounding conductor shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

Paragraph 18.5 revised October 20, 1986

PERFORMANCE

19. General

19.1 Navigation light fixtures shall comply with the applicable requirements of the tests specified in Sections 20–30. Each type and rated size of navigation light, or a representative sample of each type and rated size is to be tested. Unless specifically indicated otherwise, a navigation light is to be tested competely assembled with all integral components.

19.2 In addition to the following tests, the navigation light shall be tested in accordance with the requirements of paragraphs 5.1 and 8.2.

19.3 Operational tests of a fixture are to be conducted using the lamp specified by the fixture manufacturer (see item D of paragraph 33.1). Prior to testing, any sample of a lamp to be used is to be stabilized by operating the lamp at the rated fixture voltage for 1 percent of the lamp's average (laboratory) design life or 10 hours, whichever is the shorter duration. After the stabilization period,design voltage is to be determined and shall comply with the requirements in paragraph 11.1A. For this purpose, candlepower is to be measured in the horizontal plane and at the same distance between the lamp and photometer that will be used in the Visibility Test, Section 20. If the lamp has an Edison base, the design voltage is to be determined with the lamp in the position that produces maximum light output.

Paragraph 19.3 added October 20, 1986

19.4 The Visibility Test, Section 20, is to be conducted at the lamp design voltage. If the fixture employs an Edison base lamp and is shielded (masthead light, side light, or stern light), the test is to be repeated as necessary to verify compliance with the intensity and cut-off requirements with the lamp filament in any orientation permitted by the construction of the fixture.

Paragraph 19.4 added Octoer 20, 1986

20. Visibility Test

20.1 Navigation lights shall have sufficient intensity within their arc of visibility to provide the marked range of visibility in accordance with the requirement of paragraph 20.2.

Paragraph 20.1 revised October 20, 1986

20.2 The minimum horizontal intensity required outside the lens to achieve the desired range of visibility is specified in Table 20.1. The range of visibility shall be marked on each light as specified in paragraph 33.1.

20.3 The horizontal arc of minimum intensity specified in paragraphs 20.4, 20.6, and 20.7 shall be maintained through a vertical arc from 5 degrees below the horizontal to 5 degrees above the horizontal. The intensity shall be not less than 60 percent of the required minimum intensity through vertical arcs from 5 to 7.5 degrees below the horizontal and from 5 to 7.5 degrees above the horizontal.

Exception: A battery-powered light intended for use on unmanned barges not equipped for generation of electricity need only comply with the intensity requirements in the horizontal plane.

Paragraph 20.3 revised October 20, 1986

TABLE 20.1
CANDELAS INTENSITY FOR REQUIRED VISIBILITY

Required Range of Visibility in Nautical Miles (km)	Minimum Intensity in Candelas
1 (1.9)	0.9
2 (3.7)	4.3
3 (5.6)	12
4 (7.4)	27
5 (9.3)	52
6 (11.1)	94

The minimum intensity is to be calculated by the formula:

$$I = 3.43 \times 10^6 \times T \times D^2 \times K^{-D}$$

where: I = Luminous intensity in candelas.
T = Threshold factor, 2×10^{-7} Lux.
D = Range of visibility in nautical miles (km x 0.54).
K = Atmospheric transmissivity, 0.8.

Revised Table 20.1 effective May 1, 1988

Replaces page 14 dated October 27, 1981

20.4 Sidelights (red and green) shall maintain the required minimum intensity, for the required range of visibility, as specified in paragraph 20.2, over an arc of 112.5 degrees from right ahead to two points (22.5 degree) abaft the beam, and the light intensity shall decrease to one-eighth the required intensity within 1 to 3 degrees beyond the arc forward (minus 3 degrees) and 5 degrees beyond the arc of 112.5 degrees from right ahead (0 degrees) except that the light output may decrease to 50 percent of the required intensity between 107.5 and 112.5 degrees. See Figure 20.1. The intensity in the forward direction between 0 and 1 degrees outside the prescribed sector shall be greater than the applicable practical cutoff value specified in the International Regulations for Preventing Collisions at Sea, 1972 (72 COLREGS), COMTINST M16672.2A.

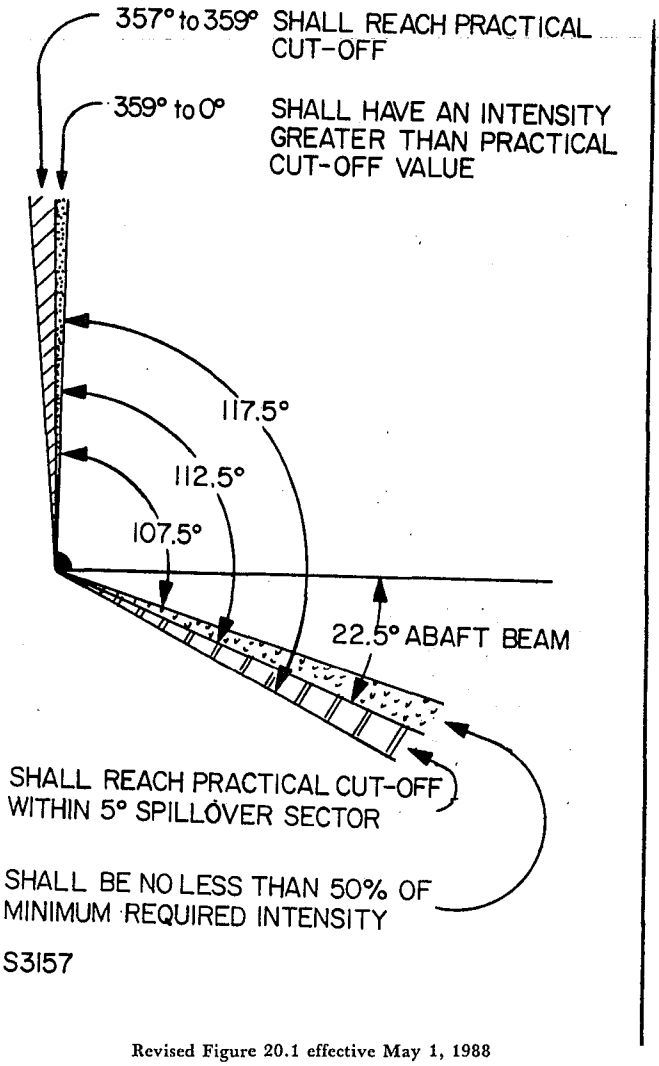
Revised paragraph 20.4 effective May 1, 1988

20.5 If a sidelight requires the use of a light screen, the screen is to be constructed and attached in accordance with the manufacturer's instructions and the International Regulations for Preventing Collisions at Sea, 1972 (72 COLREGS) COMTINST M16672.2A. See paragraph 33.1A.

Paragraph 20.5 revised October 20, 1986

20.6 Masthead lights (white) shall maintain the required minimum intensity for the required range of visibility as specified in paragraph 20.2 over an arc of 225 degrees from right ahead to 22.5 degrees abaft the beam on either side and the light intensity shall decrease to one-eighth the required intensity within 5 degrees beyond the arc on either side, except that the light output may decrease to 50 percent of the required intensity between 107.5 and 112.5 degrees on either side. See Figure 20.2.

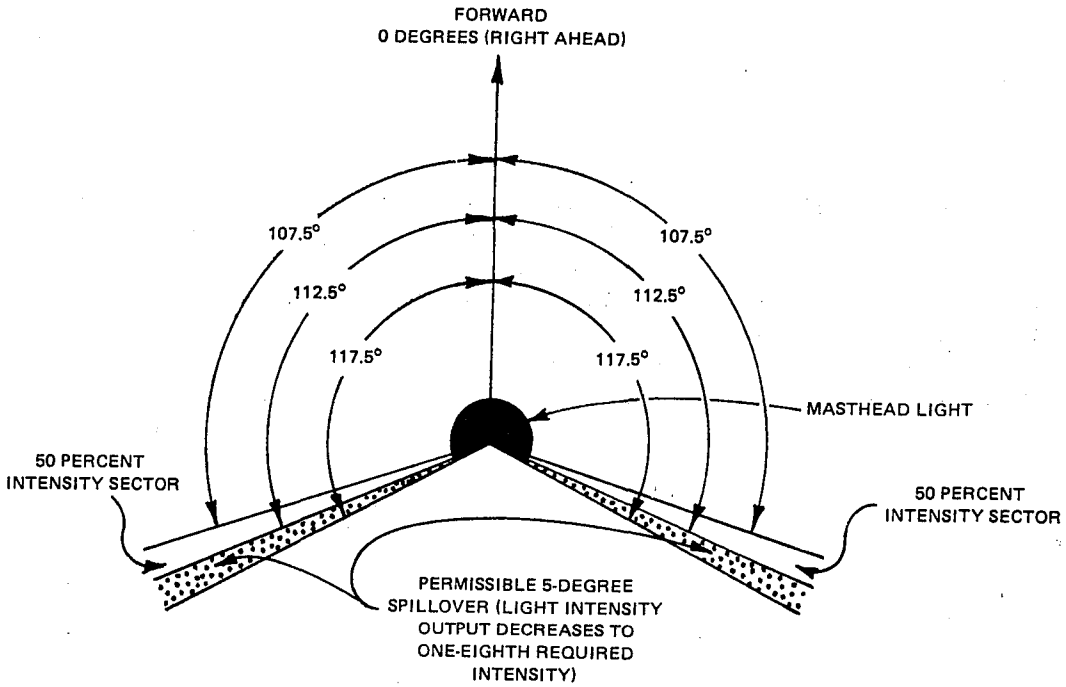
FIGURE 20.1
STARBOARD (GREEN) LIGHT
(BEAM SPREAD)[a]
[a]Port (Red) light diagram reversed.



Revised Figure 20.1 effective May 1, 1988

†*Additional page*

FIGURE 20.2
MASTHEAD LIGHT
(BEAM SPREAD)



LC149-2

Replaces page 15 dated October 27, 1981

20.7 Stern lights and towing lights shall maintain the required minimum intensity, for the required range of visibility, as specified in paragraph 20.2 over an arc of 135 degrees from the aft center line 67.5 degrees forward on either side and the light intensity shall decrease to one-eighth the required intensity within 5 degrees beyond the arc on either side, except that the light output may decrease to 50 percent of the required intensity between 62.5 and 67.5 degrees on either side. See Figure 20.3

Apparatus for Making Visibility Tests

20.8 The following test apparatus and methods are to be used for the determination of compliance with the visibility requirements for navigation lights:

A. Goniometer — Capable of 360 degrees rotation and tilt control to ± 7-1/2 degrees from the horizontal. The goniometer platform is to be used as the base for mounting the light fixture under test.

B. Photometer — A photometer system for measuring the light intensity. The system is to (1) have a spectral response within 10 percent of the 1931 CIE Standard Observer [see the Standard Recommended Practice for Spectrophotometry and Description of Color in CIE 1931 System, ASTM E308-66(1981)], (2) contain a cosine receptor or otherwise be corrected to comply with the cosine law relating the intensity of radiation entering normal to the photometer to that of radiation entering at an angle to the normal, and (3) be of such construction that the measurements follow the inverse-square law.

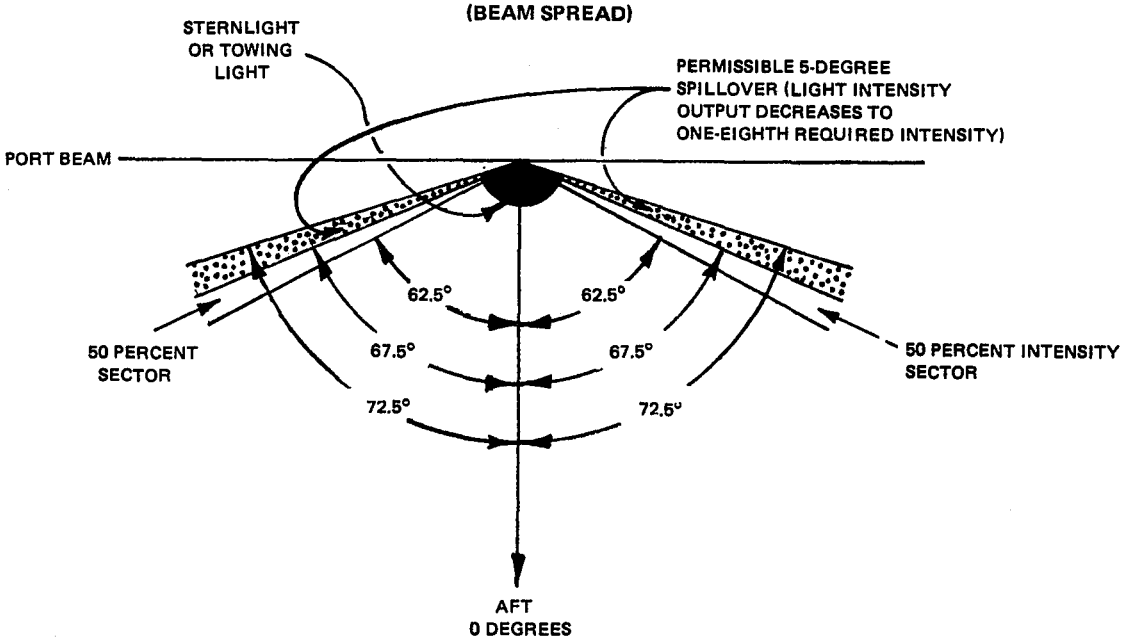
C. Indicating Instrument — A radiometer, voltmeter, or other instrument to display the results of the photometric measurements. The instrument is to be accurate to within ± 5 percent over the measurement range.

D. Dark Tunnel — Photometric tests are to be conducted in a light-tight room or tunnel with black, nonreflective walls, ceiling, and floor, and of sufficient length to permit the necessary separation of the photometer and the fixture under test. In no case is the distance between the photometer and light source to be less than 5 feet (1.5 m) or the distance between either the light source or photometer and the walls and ceiling to be less than 2 feet (0.6 m).

E. Standard Light Source — The photometric system is to be calibrated by means of a standard lamp whose calibration is to be traceable to the National Bureau of Standards. During testing of tungsten-lamp fixtures, the light source is to have a tungsten filament.

Paragraph 20.8 revised October 20, 1986

FIGURE 20.3
STERNLIGHT AND TOWING LIGHT
(BEAM SPREAD)



LC149-3

Replaces page 16 dated October 27, 1981

Method of Test

20.9 To determine compliance with the visibility requirement, the following test procedure is to be followed:

A. Deleted

B. Deleted

C. Deleted

D. The test fixture is to be mounted on the goniometer with the mounting platform in a horizontal position to permit a continuous 360-degree check of the horizontal light intensity. A plot of intensity versus azimuth is to be made. Depending on the intended use of the light, the required range of visibility and related minimum intensity in candelas shall be in accordance with Table 20.1. The required arcs of visibility shall be in accordance with paragraphs 20.4, 20.6, and 20.7 depending on the intended use. For the purpose of making this determination, the power supply wiring of a double lamp fixture may be routed or moved so as to not interfere with the optical measurements.

E. The continuous 360-degree test of the horizontal intensity is to be repeated with the goniometer platform set at an angle that positions the light fixture 5 degrees below the horizontal and then 5 degrees above the horizontal in accordance with paragraph 20.3.

F. The continuous 360-degree test of the horizontal intensity then is to be repeated with the goniometer platform set at an angle that positions the light fixture 7.5 degrees below the horizontal and 7.5 above the horizontal. In accordance with paragraph 20.3, the light intensity shall be not less than 60 percent of the required minimum horizontal intensity.

Paragraph 20.9 revised October 20, 1986

20.10 Following the arc of visibility test for each fixture, the lamps are to be replaced and the test repeated to determine compliance with paragraph 20.3.

Flashing Lights

20.11 The intensity of a flashing light is to be determined by use of the formula:

in which: $$I_e = \frac{G}{0.2 \pm t_2 - t_1}$$

I_e = Effective luminous intensity;
G = Integral of Idt, evaluated between t_1 and t_2 (Idt = Luminous intensity at the instant dt);
t_1 = Time, in seconds, at the beginning of the flash; and
t_2 = Time, in seconds at the end of the flash.

Paragraph 20.11 revised October 20, 1986

20.12 Flash tubes are to be measured with a flash meter capable of measuring effective light output.

21. Vibration Test

21.1 A representative sample of each type of navigation light assembly shall withstand vibration without development of physical malfunc tion or deterioration. If a series of lights, such as a masthead light, sidelight, stern light, and towing light, are physically identical except for light shields and lens chromaticity, a single light may be tested as representative of other lights in the series.

Paragraph 21.1 revised October 20, 1986

21.2 The light is to be mounted to a rigid test fixture in a position and manner simulating an intended ship installation. The light fixture is to be wired in a manner simulating an intended installation and is to be made operable with the power source adjusted to the nominal rated voltage of the light. The light is to be energized for 1/2 hour in each plane and is to be operationally checked after each plane of vibration. If the filament of a lamp opens during the 6-hour test, the lamp may be replaced once. A single opening of the filament is not to be cause for considering the device as not complying with these requirements.

21.3 The test sample is to be subjected to variable frequency vibration along each of three rectilinear orientation axes (horizontal, lateral, and vertical) for 2 hours in each plane (total 6 hours) at a peak-to-peak amplitude of 0.015 ± 0.001 inch (0.51 ± 0.03 mm). The frequency of vibration is to be continuously varied, at a uniform rate, from 10 to 60 to 10 hertz every 4 minutes.

Paragraph 21.3 revised October 20, 1986

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

21.5 The light shall function as intended during the test and there shall be no evidence of a malfunction or deterioration of the enclosure, the mounting means, and electrical devices, or evidence of changes in spacing or orientation of components that could alter the arcs of visibility. Gaskets or other means provided to maintain weathertight or watertight construction shall not be displaced or otherwise made ineffective. The lack of illumination of a lamp is not to be considered as noncompliance of the navigation light with these requirements.

22. Flexible Cord Tension Test

22.1 A flexible cord installed in accordance with the manufacturer's instructions shall withstand a force of 35 pounds (156 N) for 1 minute when tested as specified in paragraph 22.2.

22.2 The 35-pound (156-N) force is to be applied to the flexible cord in a direction perpendicular to the plane of the entrance to the fixture. The conductors are to be severed immediately adjacent to the terminals or splices. If there is a movement of the cord of more than 1/16 inch (1.6 mm) at the point at which the cord is secured, the construction is not acceptable.

23. Salt Spray Corrosion Test

23.1 A metal alloy or corrosion-resistant finish not known to provide corrosion-resistance equivalent to the materials specified in paragraphs 5.3 and 5.4 shall withstand 1000 hours of salt spray exposure in accordance with paragraphs 23.2, 23.3, and 23.7. The materials shall not display a loss of structural strength that would impair their intended use or result in a malfunction or deterioration that would impair the watertight construction of the assembly.

Paragraph 23.1 revised October 20, 1986

23.2 The test may be conducted with components, or samples of the material may be evaluated, except that a complete assembly is to be tested if the method of assembly, combinations of materials or methods of sealing could affect the test results. The sample is to be mounted on a test fixture to simulate an intended installation including wiring connections if the method of mounting and wiring could affect the results.

23.3 The navigation light fixture, or the set of material samples, is to be subjected to 1000 hours of exposure in accordance with the Standard Method for Salt Spray (Fog) Testing, ASTM B117-73 (1979).

Paragraph 23.3 revised October 20, 1986

23.4 *Paragraph 23.4 deleted October 20, 1986*

23.5 *Paragraph 23.5 deleted October 20, 1986*

**Replaces page 18 dated October 27, 1981*

23.6 *Paragraph 23.6 deleted October 20, 1986*

23.7 At the conclusion of the test, the fixture (reassembled if necessary) is to be operated at rated voltage. If the corrosion resulting from the test could affect the watertight construction, the fixture is to be subjected to the Watertight Thermal Shock Test, Section 24.

Paragraph 23.7 revised October 20, 1986

24. Watertight Thermal Shock Test

24.1 All fixtures shall be watertight and resistant to thermal shock when tested as specified in paragraphs 24.2 and 24.3.

24.2 To determine compliance with the requirement of paragraph 7.1, and if required by paragraph 23.7, the assembly is to be mounted as intended in service, including the method of wiring. Prior to the water impingement test, the lamps are to be removed and replaced. The light is to be energized at rated voltage for 1 hour at approximately 25±2°C. A solid stream of water from a nozzle not less than 1 inch (25.4 mm) in diameter and under a pressure of 15 psig (103.4 kPa), measured at the nozzle, is to be directed at the enclosure from a distance of 10 feet (3.1 m) for 5 minutes. The temperature of the water stream measured at the nozzle shall be 10°C.

24.3 At the end of the test, 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 cracked or broken lenses or globes due to the impingement of cold water on the heated assembly. There shall be no evidence of liquid leakage or evidence of thermal shock damage to lamps, lenses, or seals.

25. Temperature Test

25.1 As a result of the test described in paragraphs 25.2 and 25.3, temperatures shall not exceed the limits specified in Table 25.1 and the materials employed shall not show deterioration or malfunction as a result of the temperatures attained.

TABLE 25.1
TEMPERATURE LIMITS

Materials and Component	Degrees, C
Supporting surfaces	90
Combustion material in or in contact with the light	90
Insulation of supply-cable conductor	75[a]
Internal wiring	Temperature rating of wire

[a] The temperature of a supply-cable conductor may be higher than 75°C, but no higher than 95°C. See paragraph 33.4.

25.2 The navigation light to be tested is to be set up in its intended operating position on a plywood surface in a draft-free area maintained at 23 ± 2°C (73 ± 4°F). The light then is to be operated at maximum rated lamp wattage, using the intended lamps, until temperatures are attained.

Paragraph 25.2 revised October 20, 1986

25.3 The light shall be examined to determine that distortion of any component will not alter the position of the lamp(s) or housing so as to change the arcs of visibility.

25.4 A complete navigation light employing nonmetallic materials is to be subjected to an ambient temperature of minus 30±2°C for 72 hours. At the end of the 72 hours, the complete assembly is to be removed from the cold chamber, clamped to a shock table within 30 seconds and subjected to 25 shock impacts of 10 g (98 m/s^2) with each impact lasting 20–25 milliseconds. The fixture shall not crack and shall operate as intended following the impacts.

25A. Cold Ambient Test

25A.1 A navigation light shall withstand without cracking or other mechanical damage the test described in paragraph 25A.2. The navigation light shall operate as intended after the test.

Paragraph 25A.1 added October 20, 1986

**Replaces page 19 dated October 27, 1981*

25A.2 A sample of the navigation light is to be placed in a cold chamber at minus 30 ± 1°C (minus 22 ± 2°F) for 72 hours. Within 30 seconds of removal from the chamber, the sample is to be mounted to a test fixture to simulate the intended installation and the assembly (sample and test fixture) subjected to 25 shock impacts of 10 g (98 m/s^2) peak acceleration and 20—25 milliseconds duration.

Paragraph 25A.2 added October 20, 1986

26. Light and Water Test

26.1 A polymeric enclosure or part that is exposed to sunlight shall not crack or distort after 720 hours of light and water exposure as described in paragraph 26.2. This test also applies to component parts, such as gaskets, which may be in directly exposed to sunlight through a lens. Following the exposure, the reassembled fixture shall comply with the chromaticity requirements in paragraph 8.2.

Paragraph 26.1 revised October 20, 1986

26.2 The sample is to be subjected to 720 hours of light and water exposure in accordance with Method I of the Standard Practice of Operating Light-Exposure Apparatus (Carbon-Arc Type) With or Without Water for Exposure of Nonmetallic Materials, ASTM G23-81, using apparatus designated Type D or DH in ASTM G23-81. During each operating cycle of 120 minutes, the specimens are to be exposed to light alone for 102 minutes and to light and water for 18 minutes.

Paragraph 26.2 revised October 20, 1986

26.3 *Paragraph 26.3 revised and combined with paragraph 26.2 October 20, 1986*

27. Exposure to Humid Atmosphere Test

27.1 A nonmetallic part in contact with an energized component shall resist the absorption of moisture when subjected for 168 hours to air at a relative humidity of 96 ± 2 percent and a temperature equal to the maximum temperature attained by the enclosure during the Temperature Test, Section 25, or 50 ± 2°C (122 ± 4°F), whichever is greater. The sample then is to be removed from the humidity chamber and, within 1 minute of removal, subjected to the Dielectric Voltage Withstand Test, Section 29.

Revised paragraph 27.1 effective May 1, 1988

27A. Tests on Gaskets

27A.1 The insulation resistance between the live parts and dead metal parts of the fixture shall be not less than 0.25 megohm when a gasket is tested in accordance with paragraph 27A.2

Paragraph 27A.1 added October 20, 1986

27A.2 A gasket is to be immersed in a solution of 5 percent sodium chloride at room temperature for 24 hours. The gasket is then to be removed and shaken to remove loose drops of the solution, and reassembled in the fixture.

Paragraph 27A.2 added October 20, 1986

28. Lamp Life Test

28.1 To determine compliance with paragraph 11.2, five lamps shall be operated at rated voltage for 500 hours in fixtures, or equivalent enclosures, in an ambient temperature of approximately 25°C without malfunction of more than one lamp.

29. Dielectric Voltage Withstand Test

29.1 A complete navigation light and all electrical components shall withstand for 1 minute without breakdown the application of a 60 hertz essentially sinusoidal potential. The test potential shall be:

A. 500 volts for low-voltage circuits (see paragraph 29.2).

B. 2500 volts for high-voltage circuits (see paragraph 29.2).

29.2 With reference to paragraph 29.1, a low-voltage circuit is one involving a potential of not more than (1) 30 volts alternating-current (42.4 volts peak), and supplied by a primary battery or by a Class 2 transformer or by a combination of transformer and fixed impedance which, as a unit, complies with all the performance requirements for a Class 2 transformer, or (2) 50 volts nominal direct current. A high-voltage circuit is one having circuit characteristics in excess of those specified for a low-voltage circuit.

Paragraph 29.2 revised October 20, 1986

29.3 The test potentials are to be applied between live parts and dead metal parts of the navigation light.

29.4 A transformer whose output voltage is essentially sinusoidal, that can be varied, and can maintain the specified high potential voltage at the equipment during the duration of the test, is to be used to determine compliance with the foregoing. The applied potential is to be increased gradually from zero until the required test value is reached, and is to be held at that value for 1 minute.

30. Marking Plate Adhesion Tests

30.1 A pressure-sensitive label, or a label secured by adhesive or cement, shall comply with the requirements for indoor or outdoor use labels in the Standard for Marking and Labeling Systems, UL 969.

Revised paragraph 30.1 effective May 1, 1988

30.1A With reference to the requirements of paragraph 30.1, the air-oven-exposure and cold-box tests described UL 969 are to be conducted at 87°C (189°F) or the temperature specified in UL 969 corresponding to the maximum temperature attained by the labeled surface in the temperature test, Section 25 (whichever is higher) and minus 40°C (minus 40°F), respectively. The tests described in UL 969 are to be supplemented by conditioning samples of the label (applied to test surface as in the intended application) as described in paragraph 30.2A and judging the samples in the same manner as labels subjected to water immersion test described in UL 969.

Added paragraph 30.1A effective May 1, 1988

TABLE 30.1

Deletion of Table 30.1 effective May 1, 1988

30.2 Deletion of paragraph 30.2 effective May 1, 1988

30.2A Three samples of the label are to be subjected to 240 hours of salt spray exposure in accordance with the Standard Method of Salt Spray (Fog) Testing, ASTM B117-73 (1979).

Added paragraph 30.2A effective May 1, 1988

30.3 *Deletion of paragraph 30.3 effective May 1, 1988*

30.4 *Deletion of paragraph 30.4 effective May 1, 1988*

30.5 *Deletion of paragraph 30.5 effective May 1, 1988*

31. Production Line Dielectric Voltage-Withstand Test

31.1 The manufacturer shall conduct a dielectric voltage withstand test on each product or component of a product. A 40—70 hertz potential of 2500 volts shall be applied for 1 minute without breakdown between high-voltage live parts and accessible dead metal parts of high-voltage circuits that are likely to become energized.

Exception: The duration of application of the potential may be reduced to 1 second if the value of the test potential is increased to 3000 volts.

Paragraph 31.1 revised October 20, 1986

31.2 For products employing low-voltage circuits, the test is to be conducted with the low-voltage circuit connected to the cabinet, chassis, or other dead-metal part so that the potential applied between the high-voltage live parts and dead metal parts will be applied simultaneously between high-voltage live parts and low-voltage circuits.

31.3 A 500 volt-ampere or larger transformer, the output voltage of which is essentially sinusoidal and can be varied, is to be used to determine compliance with the requirements of paragraph 31.1. The requirement of a 500 volt-ampere or larger transformer can be waived if the high potential testing equipment used maintains the specified high potential voltage at the product for the duration of the test.

31.4 The test equipment for this test is to include a visible indication of application of the test potential and an audible, visible, or both audible and visual indication of breakdown. In the event of breakdown, manual reset of an external switch is to be required, or an automatic reject of the product under test is to result. Other arrangements are acceptable if they achieve the results contemplated.

32. Production Line Grounding Continuity Test

32.1 The manufacturer shall test each navigation light that has a power-supply cord terminating in an attachment plug employing a grounding pin to verify electrical continuity between the device and the grounding blade of the attachment plug.

32.2 For this test, the manufacturer is to employ an acceptable resistance-indicating instrument with leads and terminals by which the grounding circuit continuity may be determined.

**Replaces page 21 dated October 27, 1981*

MARKING

33. General

33.1 Each navigation light fixture shall be legibly and permanently marked, where the marking is visible after installation as intended, with the following:

A. Manufacturer's or private labeler's name or identifying symbol.

B. Model, type, or catalog designation.

C. Rated voltage and rated lamp wattage or candlepower.

D. Identification of the lamp(s) to be used.

E. Rated range of visibility, in nautical miles (km X 0.54).

F. Date of manufacture (see paragraph 33.2)

G. "For Use On Vessels 65 Feet Or More in Length Only," or the equivalent.

Exception: For the requirement specified in item G, a fixture as described in paragraph 3A.2 need not be so marked.

Revised paragraph 33.1 effective May 1, 1988

33.1A If light screens are needed to achieve cutoff angles complying with this standard, the following marking, or the equivalent, shall be applied to the navigation light so as to be visible, "Install with screens per manufacturer's instructions."

Paragraph 33.1A added October 20, 1986

33.2 With reference to the requirement of item F of paragraph 33.1, the date of manufacture may be by month and year, by quarter and year, or in an otherwise acceptable code.

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

33.4 If any point within the wiring compartment or fixture can be contacted by the field-installed wiring and attains a temperature of more than 60°C during the temperature test described in Section 25, the navigation light fixture shall be marked as specified in paragraph 33.5. The marking shall be legible and located so that it will be clearly visible during installation and examination of the supply wiring connections.

33.5 The marking specified in paragraph 33.4 shall state:

"For Supply Connections Use Wiring Suitable for ____°C" (see Temperature Marking in Table 33.1), or with an equivalent statement.

TABLE 33.1
TEMPERATURE FOR MARKING

Temperature Attained in Fixture	Temperature Marking
61–75°C (142–167°F)	75°C (167°F)
76–90°C (169–194°F)	90°C (194°F)

PART II NAVIGATION LIGHTS FOR USE ON BOATS AND VESSELS LESS THAN 65 FEET IN LENGTH

GENERAL

34. Scope

34.1 The requirements of Section 35—48 cover navigation lights intended to be installed only on boats and vessels less than 65 feet (20 m) in length in accordance with the applicable requirements of (1) the Standard for Fire Protection of Pleasure and Commercial Motor Craft, NFPA 302, or (2) the American Boat and Yacht Council, Inc.

Paragraph 34.1 added October 20, 1986

Replaces page 22 dated October 27, 1981

34.2 The navigation lights covered by the requirements of Sections 35—48 may be on vessels or boats subject to the Federal Boat Safety Act of 1971.

Paragraph 34.2 added October 20, 1986

34.3 The requirements of Section 35—48 cover navigation lights rated less than 50 volts dc.

Paragraph 34.3 added October 20, 1986

35. General

35.1 A navigation light shall comply with the requirements of Section 4—33, except as modified or superseded by the requirements of Sections 36—48.

Paragraph 35.1 added October 20, 1986

CONSTRUCTION

36. Enclosure

36.1 With reference to item D of paragraph 5.7, a nonmetallic enclosure material need not be classified 94V-0.

Paragraph 36.1 added October 20, 1986

36.2 With reference to item F of paragraph 5.7, the fixture is to be subjected to the temperature test specified in Section 44 in lieu of the test specified in Section 25.

Paragraph 36.2 added October 20, 1986

37. Lenses and Globes

37.1 A lens or globe shall be constructed for operation in a minus 30 to plus 40°C (minus 22 to plus 104°F) ambient temperature range. See Temperature Test, Section 44.

Paragraph 37.1 added October 20, 1986

38. Gaskets and Bushings

38.1 A gasket or bushing need not comply with the insulation resistance requirements specified in paragraph 9.2, but shall be formed of material that will not result in an unacceptable leakage current if exposed to moisture. See Exposure to Humid Atmosphere Test, Section 45, and Stray Current Leakage Test, Section 46.

Paragraph 38.1 added October 20, 1986

39. Electrical

Wire

39.1 External wiring shall comply with the requirements of 33 CFR 183.425 and 183.430.

Paragraph 39.1 added October 20, 1986

Splices

39.2 A splice shall be made with an insulated pressure wire connector, or the equivalent.

Exception: An internal splice may be soldered if the connected wiring is supported or otherwise secured to reduce the likelihood of movement.

Paragraph 39.2 added October 20, 1986

PERFORMANCE

40. General

40.1 Operational tests are to be conducted in accordance with paragraphs 19.3 and 19.4.

Paragraph 40.1 added October 20, 1986

41. Visibility Tests

41.1 In lieu of compliance with the requirements in paragraphs 20.1 and 20.3—20.7, a navigation light may comply with the requirements in paragraphs 41.2—41.6.

Paragraph 41.1 added October 20, 1986

41.2 To achieve the marked range of intensity, the horizontal intensity outside the lens shall be not less than the applicable value specified in Table 20.1.

Paragraph 41.2 added October 20, 1986

41.3 The horizontal arc of minimum intensity specified in paragraphs 41.4—41.6 shall be maintained through a vertical arc from 5 degrees below to 5 degrees above the horizontal. For a light intended for use on motor boats, the intensity shall be not less than 60 percent of the required minimum intensity through vertical arcs from 5 to 7.5 degrees both above and below the horizontal. For a light intended for use on sailboats, the intensity shall be not less than 50 percent of the required minimum intensity through vertical arcs from 5 to 25 degrees both above and below the horizontal. See Figure 41.1.

Paragraph 41.3 added October 20, 1986

†*Additional page*

FIGURE 41.1
VERTICAL PROFILES AT MIDSECTOR
(Applies to 100% horizontal intensity sectors —
shaded areas represent unacceptable intensity ranges)

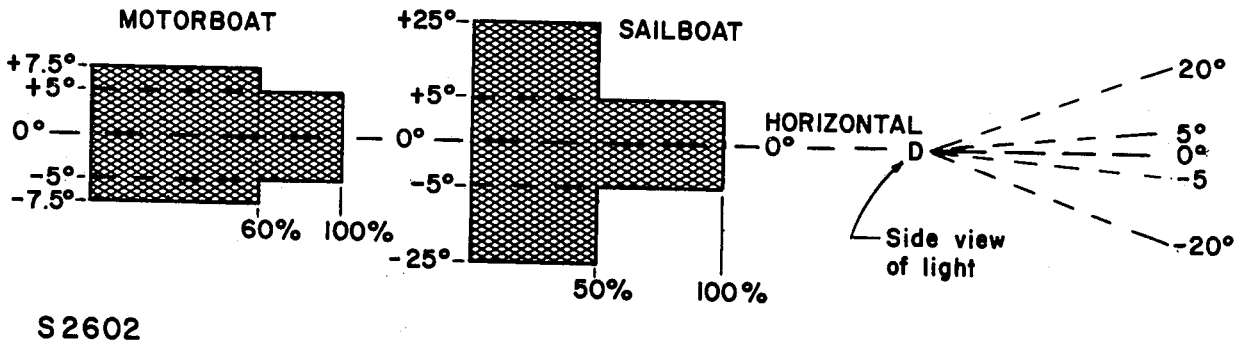


Figure 41.1 added October 20, 1986

41.4 A sidelight (red or green) shall maintain the required minimum intensity, for the required range of visibility as specified in Table 20.1, over an arc of 112.5 degrees from right ahead to two points (22.5 degrees) abaft the beam, and the light intensity shall decrease to not more than 67 percent of the required intensity within 3 degrees beyond the arc forward (minus 3 degrees) and 5 degrees beyond the arc of 112.5 degrees from right ahead (0 degrees); except that the light output may decrease to 50 percent of the required intensity between 107.5 and 112.5 degrees. At 20 degrees beyond and 132.5 degrees from forward, the light output shall decrease to not more than 10 percent; with the required maximum intensity decreasing linearly between the 3—20 degrees beyond and 117.5—132.5 degrees from forward arcs. See Figure 41.2.

Paragraph 41.4 added October 20, 1986

41.5 A masthead light (white) shall maintain the required minimum intensity, for the required range of visibility as specified in Table 20.1, over an arc of 225 degrees from right ahead to 22.5 degrees abaft the beam on either side and the light intensity shall decrease to not more than 67 percent of the required intensity at 117.5 degrees and 242.5 degrees or 5 degrees beyond the arc on either side; except that the light output may decrease to 50 percent of the required intensity between 107.5 and 112.5 degrees and between 252.5 and 247.5 degrees on either side. The light intensity shall decrease to not more than 10 percent at 132.5 and 227.5 degrees or 20 degrees beyond the arc; with the required maximum intensity decreasing linearly in the 117.5—132.5 and 242.5—227.5 degrees arcs.

Paragraph 41.5 added October 20, 1986

FIGURE 41.2
VERTICAL VISIBILITY PROFILES
(Shaded areas represent unacceptable intensity ranges)

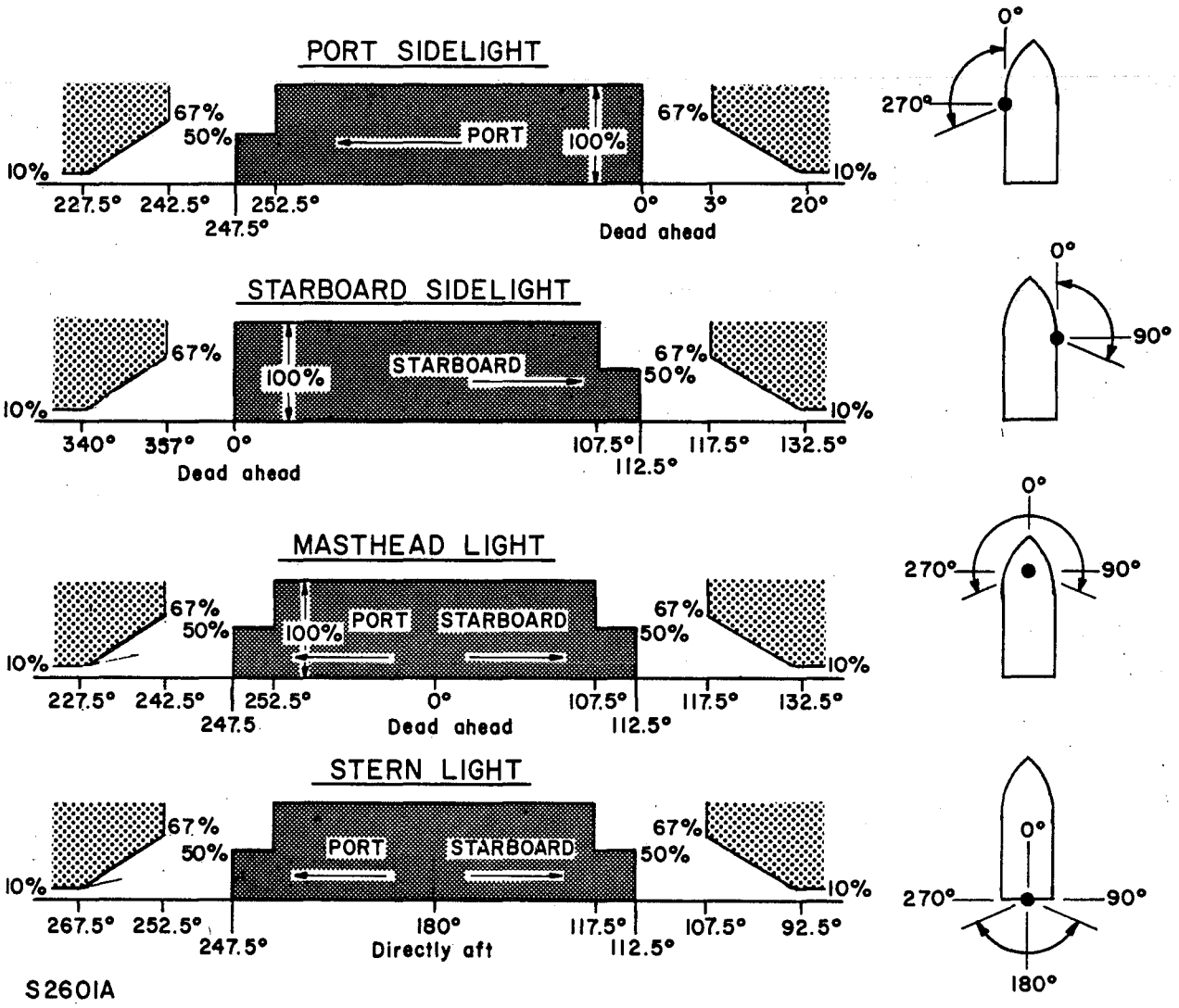


Figure 41.2 added October 20, 1986

41.6 A stern light shall maintain the required minimum intensity, for the required range of visibility as specified in Table 20.1, over an arc of 135 degrees from the aft center line to 67.5 degrees forward on either side and the light intensity shall decrease to not more than 67 percent of the required intensity within 5 degrees either side; except that the light output may decrease to 50 percent of the required intensity between 62.5 and 67.5 degrees on either side. The light intensity shall decrease to not more than 10 percent, 20 degrees beyond the arc of 72.5 degrees on either side, with the required maximum intensity decreasing linearly in the 72.5—92.5 degree arcs on either side.

Paragraph 41.6 added October 20, 1986

42. Vibration Test

42.1 The vibration specified in paragraph 21.3 is to be maintained for 4 hours in each axis (total of 12 hours).

Paragraph 42.1 added October 20, 1986

43. Shock Test

43.1 A navigation light shall withstand 5000 impacts without malfunction, displacement or loosening of parts, or changes in alignment.

Paragraph 43.1 added October 20, 1986

43.2 The sample used in the Vibration Test, Section 21 and 42, is to be used for this test.

Paragraph 43.2 added October 20, 1986

43.3 The sample is to be mounted in the test fixture described in paragraph 21.2. The assembly (sample and test fixture) then is to be subjected to 5000 shock impacts, each having an acceleration of 10 g [322 feet per second per second (98 m/s^2)] and a duration of 20—25 milliseconds as measured at the base of the half-sine shock envelope.

Paragraph 43.3 added October 20, 1986

44. Temperature Test

44.1 When tested in accordance with paragraphs 44.2 and 44.3, a nonmetallic material forming part of the enclosure of a navigation light shall not ignite or smolder, nor shall it deform to an extent that the light will not comply with the requirements of the Visibility Test, Section 41, or the Watertight Thermal Shock Test, Section 24.

Paragraph 44.1 added October 20, 1986

44.2 The fixture is to be mounted on plywood or fiberglass in a manner simulating intended installation in a cabin side or boat hull. If the fixture may penetrate the hull, three layers of cheesecloth are to be stretched across the exposed inboard parts.

Paragraph 44.2 added October 20, 1986

44.3 The fixture then is to be placed in a draft free chamber and continuously operated for 48 hours at rated voltage. The chamber is to be maintained at $40 \pm 3°C$ ($104 \pm 5°F$) during the test.

Paragraph 44.3 added October 20, 1986

45. Water and Thermal Shock Test

45.1 When tested as described in paragraphs 24.2 and 24.3, water may enter the enclosure of a navigation light, but such entry shall not interfere with the intended operation of the light.

Paragraph 45.1 added October 20, 1986

46. Exposure to Humid Atmosphere Test

46.1 With reference to paragraph 27.1, in lieu of the Dielectric Voltage-Withstand Test, Section 29, the sample is to be subjected to the Stray Current Leakage Test, Section 46, within 1 minute after removal from the chamber.

Paragraph 46.1 added October 20, 1986

47. Stray Current Leakage Test

47.1 The leakage current shall not exceed 1 milliampere while a 500 volt direct-current potential is applied for 1 minute between current-carrying parts and dead metal parts (including mounting provisions) of a navigation light.

Paragraph 47.1 added October 20, 1986

†*Additional page*

47.2 This test is to be conducted in lieu of the Dielectric Voltage-Withstand Test, Section 29.

Paragraph 47.2 added October 20, 1986

47.3 The applied potential is to be increased at a rate of approximately 50 volts per second until the specified value is reached, and maintained for 1 minute. The potential then is to be reduced to zero at the rate at which it was applied.

Paragraph 47.3 added October 20, 1986

48. Marking Plate Adhesion Tests

48.1 With reference to paragraph 30.1A, the air-oven-exposure test is to be conducted at 87°C (189°F) or the maximum temperature attained by the labeled surface during the temperature test specified in Section 44.

Paragraph 48.1 added October 20, 1986

MARKING

49. General

49.1 In lieu of compliance with the requirement of item G of paragraph 33.1, a fixture shall be marked "For Use On Vessels Less Than 65 Feet Only," or the equivalent.

Paragraph 49.1 added October 20, 1986

49.2 The marking specified in paragraphs 33.4 and 33.5 shall be based on the maximum temperature attained during the temperature test specified in Section 44.

Paragraph 49.2 added October 20, 1986

49.3 The markings specified in items A, B, and D of paragraph 33.1 and in paragraph 33.3 shall be provided on a navigation light fixture, and these markings need only be visible after the fixture is disassembled for servicing such as lamp replacement. The markings specified in items C and E of paragraph 33.1 and in paragraphs 49.1 and 49.2 shall be either provided on the fixture or a separate instruction sheet, or the smallest unit container in which the fixture is packaged. The marking specified in item F of paragraph 33.1 is not required.

Paragraph 49.3 added October 20, 1986