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Ships and marine technology — Searchlights for high-speed craft

Navires et technologie maritime — Feux de recherche pour navires à grande vitesse

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 17884 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 6, *Navigation*.

Ships and marine technology — Searchlights for high-speed craft

1 Scope

This International Standard applies to searchlights fitted to high-speed craft in accordance with the International Code of Safety for High-Speed Craft [HSC Code, IMO-Resolution MSC.36 (63) Chapter 13].

Searchlights on board high-speed craft (HSC) facilitate the detection of other vessels, offshore structures, obstructions to shipping, floating objects and living things, shorelines, as well as fixed and floating sea marks and other aids to navigation, thus providing essential information to the navigator for safe navigation, collision avoidance and search and rescue of shipwrecked persons at sea.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 719, *Glass — Hydrolytic resistance of glass grains at 98 °C — Method of test and classification*

ISO 10012, *Measurement management systems — Requirements for measurement processes and measuring equipment*

ISO/CIE 10527, *CIE standard colorimetric observers*

CIE Publication No. 15.2, *Colorimetry*

CIE Publication No. 70, *The measurement of absolute luminous intensity distributions*

IEC 60068-2-27, *Environmental testing — Part 2: Tests — Test Ea and guidance: Shock*

IEC 60092-101, *Electrical installations in ships — Part 101: Definitions and general requirements*

IEC 60092-201, *Electrical installations in ships — Part 201: System design — General*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60598-1, *Luminaires — Part 1: General requirements and tests*

IEC 60598-2-5, *Luminaires — Part 2: Particular requirements — Section 5: Floodlights*

IEC 60945, *Maritime navigation and radiocommunication equipment and systems — General requirements — Methods of testing and required test results*

IMO Resolution A.694 (17), *General Requirements for Shipborne Radio Equipment forming Part of the Global Maritime Distress and Safety System (GMDSS) and for Electronic Navigational Aids*

IMO Resolution A.813 (19), *General Requirements for Electromagnetic Compatibility (EMC) for all Electrical and Electronic Ship's Equipment*

IMO Resolution MSC.36 (63), *International Code of Safety for High-Speed Craft*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
searchlights
locally fixed lights suitable for controlled transmission of defined light by focused light beams

3.2
high-speed craft
HSC
any craft to which the definition in Chapter 1 of the HSC Code applies

3.3
zero position of the optical light axis
position of the optical light axis of the searchlight parallel to the water surface pointing in the direction right ahead

3.4
switch-on time
period of time required for reaching 95 % of the required luminous intensity after the searchlights have been switched on

3.5
half-peak divergence
α_h
angular extent of all the radius vectors of the polar curve of luminous intensity in the specified plane having lengths greater than 50 % of the maximum

3.6
tenth-peak divergence
α_t
angular extent of all the radius vectors of the polar curve of luminous intensity in the specified plane having lengths greater than 10 % of the maximum

4 Requirements

4.1 Required functions and their availability

At night, searchlights shall be capable of locating objects within a sufficient distance from one's own craft. The searchlights shall be provided with an electrical, hydraulic or pneumatic remote control for pan and tilt movement.

4.2 Permanent operation and life duration

Searchlights shall be suitable for permanent operation. When tested in accordance with 5.3, a life duration of the illuminant of at least 100 h shall be reached.

4.3 Luminous intensity

The luminous intensity in the focused position of searchlights shall be minimally 2×10^6 cd. This equals an illumination of 5,6 lx at a distance of 600 m with an atmospheric transmission of 0,8.

The luminous intensity of searchlights shall have its maximum in the centre of the luminous intensity distribution. With focus in any position, a homogenous luminous intensity distribution shall be ensured, i.e. the central spot area with at least 80 % of the maximum luminous intensity shall show no position with less than 80 % of the maximum luminous intensity.

The half-peak divergence α_h shall be between 3° and 8°, and the tenth-peak divergence α_t shall not exceed 14°. The half-peak divergence α_h may be smaller than 3° if focusing is possible during operation.

In case of a non-circular beam profile, the longer axis of the profile shall be orientated horizontally.

4.4 Chromaticity of the emitted light

The chromaticity of the emitted light of searchlights shall lie within corner coordinates in the International Commission on Illumination (CIE) chromaticity diagram, see Table 1.

Table 1 — Chromaticity coordinates

Chromaticity coordinates (corner coordinates)	x	0,452	0,310	0,310	0,443
	y	0,440	0,348	0,283	0,382

4.5 Switch-on time

The switch-on time of searchlights shall be max. 30 s.

3 s after the searchlights have been switched on, at least 70 % of the required luminous intensity shall be reached.

In case this requirement can only be reached from the stand-by modus, advice on this respect shall be included in the documentation, see Clause 7.

4.6 Pan and tilt ranges

The optical light axis of searchlights shall be capable of being panned at least 175° horizontally to either side and tilt min. 30° downward and min. 30° upward, starting from the zero position.

4.7 Pan and tilt speeds

The speeds of panning and tilting shall be variable in at least five different speeds in the required range.

— The minimum horizontal panning speed shall not be greater than 5°/s and the maximum horizontal panning speed shall not be smaller than 10°/s.

— The minimum vertical tilting speed shall not be greater than 0,5°/s and the maximum vertical tilting speed shall not be smaller than 5°/s.

4.8 Malfunctions, warnings, alarms and indications

The control unit of searchlights shall be fitted with an indication of the operational status and a visual indication of any failure of the searchlight. The remote control shall display the following status of the searchlight:

— stand-by, if applicable;

— on;

— fault.

Additional lights at the remote-control unit or the power supply box shall display which special part of the searchlight (for example, light source, power supply, remote control) caused a fault.

4.9 Ergonomic and operational controls

The operational controls of the searchlight shall be within easy reach from the conning position.

The number of operational controls shall be limited to the minimum required for operation.

Double functions of operational controls shall be avoided. Joysticks are excluded from this requirement.

A set of operational controls shall just be used to operate only one searchlight.

If the operational controls are released by the operator, the searchlight shall remain in the last selected position and shall not be moved from this position, e.g. by wind or movement or vibration of the craft or any other influences.

The functions of the individual operational controls shall be clearly labelled.

The operational controls shall be clearly identifiable in the dark. If illumination is used, the brightness shall be adjustable.

The operational controls of searchlights shall meet the requirements of IMO Resolution A.694 (17) and the applicable requirements of IEC 60945.

4.10 Durability and resistance to environmental conditions

Searchlights shall be constructed in accordance with IEC 60598-1 and dimensioned in such a way that they will present no hazard to persons, in particular during operation and maintenance work. Searchlights shall be constructed in such a way that

— they can be easily cleaned inside, if applicable;

— only unbreakable and reusable gaskets are used between removable parts, as far as applicable;

— a degree of protection of at least IP 56 in accordance with IEC 60529 is reached;

— the accumulation of condensed water in the housing in hazardous quantities is avoided;

— in the case of light emission areas made of silicate glass, a type of glass of at least hydrolytic class IV in accordance with ISO 719 shall be used.

Illuminant holders shall be designed and manufactured in such a way that only the appropriate illuminant can be fitted and the illuminant can be easily replaced. Mounting of the illuminant within the searchlight in any wrong position shall not be possible. The illuminant shall be safely fitted in the searchlight.

In searchlights, only illuminants designed for and type-approved together with that particular type of searchlight shall be used.

At nominal voltage, the average lifetime of an illuminant when fitted to the searchlight should be at least 100 h.

The luminous intensity of the illuminant shall not be adjustable by any variable control.

The construction of searchlights shall be such as to assure that no disturbing reflection or refraction of light can occur and no light of a colour other than intended can be given out.

Searchlights and any accessories e.g. power-supply unit and controls, shall each be measured for their safe magnetic distance.

The materials used shall withstand the influences occurring during operation. With respect to durability and resistance to environmental conditions, searchlights shall meet the requirements specified in IMO Resolution

A.694 (17) and in the applicable requirements of IEC 60092-101 and IEC 60945, and shall comply with the vibration test in accordance with IEC 60945, with the deviations of test parameters in accordance with 5.4 and a shock test in accordance with 5.5.

4.11 Steadiness and ultimate behaviour of pane (light emitting areas)

The steadiness shall be in accordance with ISO 719, if applicable.

The required ultimate behaviour of the searchlight's pane, in case of destruction, shall meet the requirements specified in IEC 60598-2-5.

4.12 Electromagnetic compatibility (EMC)

With respect to electrical and electromagnetic compatibility, searchlights shall meet the requirements of IMO Resolutions A.694 (17) and A.813 (19) and IEC 60945.

4.13 Power supply

The power supply of searchlights shall meet the requirements of IMO Resolution A.694 (17) and IEC 60092-201.

4.14 Installation

Searchlights shall be installed in such a way that

— the emission sector of searchlights in the zero position of the optical light axis is free of obstructions,

— within the horizontal panning area of searchlights, in the sector reading 112,5° to either side, there are no obstructions with a core shadow bigger than 3°,

— two core shadows are separated by an unobstructed field of vision of at least 30°,

— in a sector from 112,5° to min. 175°, and from min. 185° to 247,5°, core shadows are kept to a minimum; inevitable core shadows covering more than 15° shall be clearly indicated on the respective operational controls,

— in the emission sector of searchlights, in the direction right ahead, visibility of the water surface for the vertically tilted searchlight is not reduced by more than two ship's lengths by the blind angle of one's own craft or 500 m, whichever is less.

With respect to installation, searchlights shall meet the requirements of IMO Resolution A.694 (17) and the applicable requirements of IEC 60598-1.

Searchlights shall be designed and mounted in such a way that their operational functions are not impaired by wind up to 100 kn and roll and/or pitch angles up to ± 10°.

Their light emission shall not be impaired by vibration occurring during normal operation of the craft.

4.15 Maintenance

With respect to maintenance, searchlights shall meet the requirements of IMO Resolution A.694 (17) and IEC 60598-1. The searchlight shall be accessible from a safe position and shall be capable of being opened by a person wearing heavy working gloves.

4.16 Back-up and fall-back arrangements

Each searchlight shall be provided with at least one spare illuminant, which is type approved together with that particular type of searchlight.

4.17 Safety precautions

The safety features of searchlights shall meet the requirements of IMO Resolution A.694 (17) and IEC 60598-1.

5 Type approval tests

5.1 Testing of the luminous intensity

5.1.1 General

The voltage for testing intensity and colour shall be the nominal voltage ± 0,1 %. In the case of the illuminant being interchangeable, the change of the illuminant has to be executed three times, while testing readings have to stay within the permitted tolerances. In this case, the following light test has to be repeated three times.

If more than one type of illuminant is allowed to be used in a searchlight, the complete type approval test is required for each illuminant.

If focusing of the searchlight is possible, five measurement profiles of the luminous intensity shall be taken. The focus must be set to the focused position, to the maximum defocused position and to three evenly distributed positions between these positions.

5.1.2 Adjustment

The searchlight shall be fastened onto a goniophotometer with clamping devices produced by the searchlight manufacturer, in such a way that unimpeded light emission in all directions of the searchlight light emission area is possible. Taking the centre of the optical system as the rotation point, either the searchlight to be tested or the photometer, respectively the colorimeter, shall be turned and inclined horizontally and vertically in steps according to the particular requirements.

5.1.3 Goniometry

Goniometry between the photodetector and sample shall provide a 360° measurement around the optical axis of the searchlight while the searchlight shall be able to be inclined up to 25° from its optical axis, both the horizontal and vertical angles being measurable within ± 0,1° and accurate to ± 0,1°.

5.1.4 Photometer

A photometer suitable for measurement of directional light shall have a fine adjustment to human photopic vision (V_λ-curve) in terms of spectral luminous efficiency. It shall be fitted with a tube shielding the acceptance area against reflected light without keeping off direct incident light. The photometer head shall be temperature-stabilized to prevent ambient temperature influences. The photometer shall be calibrated from approximately 0,01 lx to approximately 10 000 lx using calibrated neutral filters (in case of illuminants with luminous intensities that are too high). The photometer and the filters shall be calibrated using measurement standards that are traceable to national measurement standards. Extraneous light shall not have any significant effect upon the detector. Means shall be provided to prevent this, if necessary (see CIE Publication No. 70).

The photometer shall be capable of measuring luminous intensity within an accuracy of 3 %.

Before testing, the components of the optical system of the test searchlight should be cleaned carefully, if necessary, without damage or scratching the components, or adversely affecting any optics contained in the components.

5.1.5 Geometry

The distance between the illuminant of the searchlight and the photometer head shall be in accordance with the Photometric Distance Law and shall exceed the Limiting Photometric Distance in accordance with CIE Publication No. 70.

5.1.6 Procedure

The test searchlight used in checking chromaticity and luminous intensity shall be representative of standard searchlights in regular production, but does not have to be a searchlight out of serial production.

All measurement units shall conform to ISO 10012.

The photometric tests shall be performed in accordance with CIE Publication No. 70.

The photometric tests and the colorimetric test shall be performed in a darkened room with low-reflecting neutrally coloured walls, floor and ceiling, especially near the searchlight testing arrangement, in order to make sure that only the intensity or colour of lights of the direct light emission of the tested searchlight is recorded by the photometer or by the colorimeter.

The photometer and the colorimeter shall be fitted with a tube of black colour which reduces interior reflection without screening the acceptance area. The photometer head and the colorimeter head shall be temperature-stabilized to prevent ambient temperature influences. Inside and in front of the tube, diaphragms covered with black velvet or similar light-absorbing material shall be placed. They shall be provided with an aperture slightly larger than the acceptance area of the photometer head or the colorimeter head to avoid measuring errors due to reflected light or colour changes of the light.

The searchlight under test shall be properly seasoned using a representative production illuminant which is designated by the manufacturer of this searchlight, so that the measurements taken on the searchlight are stabilized. Before starting the test, the illuminant of the searchlight to be tested shall be aged over a period of 0,5 h of operation with the highest voltage possible in accordance with IEC 60092-201.

This voltage (burning voltage) specified by the manufacturer, shall be measured at, or close to, the terminals of the illuminant. For this purpose, the manufacturer shall provide the searchlight under test with additional leads. The illuminant used in the test shall be the same as the illuminant specified by the searchlight manufacturer.

These tests shall be repeated with the first searchlight of every type out of the serial production.

5.1.7 Angles

Luminous intensity shall be measured and recorded continuously, with the optical axis of the searchlight and optical axis of the photometer in line while the searchlight is rotated around its optical axis by 360°. Then the searchlight shall be inclined by 1° from the axis of the photometer and the luminous intensity shall be measured again while the searchlight is rotated around its optical axis by 360°. This procedure shall be repeated in steps of 1°, up to an angle of inclination of 10° from the axis of the photometer.

Additionally, three linear measurement profiles crossing the whole light beam and with the optical axis of the searchlight as symmetry shall be taken, each situated 120° relative to each other, from – 30° inclination linear through the axis to 30° of inclination.

If turning of the searchlight in the above-described way is not possible, only linear profiles of the luminous intensity shall be taken. After aligning the optical axes of the photometer and the searchlight, the measurement shall be started and the searchlight shall be turned around its vertical axis up to 10° to both sides. Then the searchlight shall be inclined by 1° and the next linear profile shall be recorded. This procedure

shall be repeated with all possible angles in all four directions vertical and horizontal relative to the optical axis of the searchlight from 0° up to 10° in steps of 1,0°.

5.1.8 Measurement of luminous intensity

The luminous intensity shall be continuously measured and recorded.

5.2 Testing of the chromaticity

5.2.1 Adjustment

See 5.1.2.

5.2.2 Goniometry

See 5.1.3

5.2.3 Colorimeter

A colorimeter suitable for measurement of coloured light shall be capable of measurement of the chromaticity of the light emanating from the searchlight to be tested. The colorimeter shall have the following characteristics.

— It shall be precisely adjusted, by means of partial filtering, or similar methods, to the CIE colour-matching functions $\bar{x}(\lambda)$, $\bar{y}(\lambda)$, and $\bar{z}(\lambda)$ for the 2° field of vision in accordance with ISO/CIE 10527. Extraneous light shall not have a significant effect upon the detector. Means shall be provided to prevent this, if necessary.

— It shall have a sensitivity of min. 1 lx.

The colorimetric measuring system shall be checked prior to the tests by means of photometric standard illuminant A (2 856 K) and with red, green and blue filters of which the colour coordinates are measured by a calibrated colorimeter.

The colorimetric tests of the colours of lights shall be performed with the searchlights under simulated operating conditions by means of tristimulus colorimetry using a high-precision colorimeter for absolute measurements, in accordance with CIE Publication No. 15.2.

The colorimeter and the filters shall be calibrated using measurement standards that are traceable to national measurement standards.

The components of the optical system of the searchlight should be cleaned carefully, if necessary, before the test begins, but without injury or scratching the components, or adversely affecting any optics contained in the components.

5.2.4 Geometry

The measuring distance between the illuminant of the searchlight and the colorimeter head shall be adjusted in such a way that the 2° field of vision in accordance with ISO/CIE 10527 is observed.

5.2.5 Procedure

See 5.1.6.

5.2.6 Measurement of chromaticity

The colorimetric test shall be performed by means of goniophotometers, with measurements taken at least ten times at different positions within the illuminated sector.

5.3 Test of life duration (see 4.2)

The searchlight shall be permanently operated under the following conditions:

— nominal voltage ± 0,1 %;

— ambient temperature between + 15 °C and + 35 °C;

— draught-free air.

The test shall be repeated with a second illuminant of the same type.

5.4 Vibration

5.4.1 General

The vibration test shall be carried out in accordance with IEC 60945 using the parameters given in Table 2.

Table 2 — Parameters of vibration

Frequency range	Displacement	Acceleration
2^{+3}_{-0} Hz up to 15 Hz	± 2,5 mm	
15 Hz up to 100 Hz		2,3 g
Sweep rate	max. 0,5 octave/min	

5.4.2 Pre-conditioning and initial measurements

The searchlight under test, including any component, e.g. remote control, separate power supply unit or terminal boxes, is fastened by means of fastening devices in the normal mounting position in accordance with the manufacturer's instructions. The tests are performed in three mutually perpendicular axes (X:Y:Z). During the test, the intended use shall be demonstrated. Prior to the test, the points of resonance of each axis shall be determined.

— If the points of resonance are determined on the searchlight under test, and if such points have an amplification factor $Q < 2$, the test duration is 90 min per axis at a frequency of 30 Hz.

— If the points of resonance are determined on the searchlight under test, and if such points have an amplification factor $Q \geqslant 2$, the test duration is 90 min per resonance frequency.

In the case of several resonance frequencies being detected close to each other, a sweep test can be performed instead. The duration of the sweep test is 120 min.

5.4.3 Required result

The searchlight shall show no damage and the specified functions shall be demonstrated.

5.5 Shock

5.5.1 General

The shock test shall be carried out in accordance with IEC 60068-2-27 using the parameters given in Table 3.

Table 3 — Parameters of the shock pulse

Peak acceleration (a)	15 g (equivalent to 150 m/s^2)
Duration of the pulse (T)	11 ms
Pulse shape	Half-sine pulse

The test has to be performed in three mutually perpendicular axes (X,Y,Z). Three shocks shall be performed in each of the six directions.

5.5.2 Pre-conditioning and initial measurements

The searchlight under test, including any component, e.g. remote control, separate power supply unit or terminal boxes, shall be fastened by means of its fastening devices in its normal mounting position in accordance with the manufacturer's instructions. During the test, the intended use shall be demonstrated.

5.5.3 Required result

The searchlight shall show no damage and the specified functions shall be demonstrated.

6 Test report

The test report shall include at least the following information:

a) reference to this International Standard;

b) specifications of the searchlight under test;

c) specifications of the illuminant(s) under test;

d) serial number of searchlight, if applicable;

e) all required test results (e.g. readings of burning voltage, diagrams of luminous intensity distribution, chromaticity coordinates, result of life test, proof of the required ultimate behaviour, if applicable);

f) date of test;

g) test institution;

h) department and person responsible.

7 Documentation

Searchlights shall be delivered complete with their technical documentation. Such documentation shall include the following information, if applicable.

a) Safety instructions.