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Small craft — Electrical devices — Lightning-protection systems

Petits navires — Dispositifs électriques — Dispositifs de protection contre la foudre

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Contents

Page

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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10134 was prepared by Technical Committee ISO/TC 188, *Small craft*.

This second edition cancels and replaces the first edition (ISO 10134:1993),which has been technically revised.

Small craft — Electrical devices — Lightning-protection systems

1 Scope

This International Standard establishes guidelines for the design, construction and installation of lightning-protection systems fitted on small craft of hull length up to 24 m.

NOTE The probability of a lightning strike varies with geographic location and time of year, but when the conditions that create an electrical discharge between clouds and the earth exist, there is nothing that can be done to prevent the lightning discharge. Craft can be struck in open water or when tied to the dock. The presence of a lightning-protection system on a craft cannot provide complete protection from equipment damage or personal injury and such protection is not implied in this International Standard.

2 Terms and definitions

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

2.1
air gap
interruption of a conductive path by a small air space not exceeding 2 mm in order to prevent the passage of low-voltage current without interrupting the flow of lightning current

2.2
air terminal
uppermost part of the lightning-protection system, intended to dissipate the charge or start the lightning ground process

2.3
lightning ground plate
lightning ground strip
means to conduct the electrical current from a boat's conductive elements to the water in which the boat floats

2.4
lightning-protective mast
conductive structure or means for electrical connection of an air terminal to the lightning ground plate

2.5
side flash
an arc-over discharge that occurs from the lightning-protection system to any metal object

2.6
lightning bonding conductor
conductor intended to be used for potential equalization between metal bodies and the lightning-protection system

2.7
lightning grounding conductor
conductor installed to connect the air terminal or the lightning-protective mast to the lightning ground plate

2.8
protection zone
zone below a grounded air terminal, mast or overhead ground wire which is substantially immune to direct strokes of lightning

NOTE 1 Complete protection from equipment damage or personal injury is not implied.

NOTE 2 A lightning-protection system offers no protection when the boat is out of water and is not intended to afford protection if any part of the boat comes in contact with power lines while afloat or ashore.

3 General requirements

3.1 Protection of persons and small craft from lightning is dependent upon a combination of design and maintenance of equipment and on personnel behaviour. The basic guides contained in this International Standard shall be considered and used in designing and installing a lightning-protection system. However, in view of the wide variation in structural design of boats and the unpredictable nature of lightning, specific recommendations cannot be made to cover all cases.

3.2 To provide an adequate lightning grounding conductor or lightning-protective mast, the entire circuit from the top of the lightning-protective mast to the lightning ground plate shall have a mechanical strength and a conductivity not less than that of a 21 mm^2 copper conductor, and the path to ground followed by the conductor shall be essentially straight. Additional recommendations may be found in IEC 60092-352[2].

3.3 If there are large metal objects such as tanks, engines, deck winches, stoves, etc. within 2 m of any lightning grounding conductor, there will be a strong tendency for sparks or side flashes to jump from the grounding conductor to the metal object at the closest point. To prevent damage from such side flashes, an interconnecting lightning bonding conductor at least equivalent to 13 mm^2 copper (see 4.2.1) shall be provided at all places where they are likely to occur. Additional recommendations may be found in IEC 60092-352[2].

3.4 Large metallic objects which are not part of the electrical system of the craft and which are not already grounded due to their own functional or other requirements, may be grounded directly to the lightning ground plate, provided that it is not practical to interconnect with the lightning grounding conductor or lightning bonding conductor as discussed in 3.2 and 5.4.

3.5 Where a lightning-protection system is installed on a craft, the owner's manual shall include the information specified in Annex A.

4 Materials

4.1 Corrosion resistance

The material used in a lightning-protective system shall be resistant to corrosion. If, as in certain installations, it is impractical to avoid a junction of dissimilar metals, the corrosion effects can be reduced by the use of suitable platings or special connectors that are galvanically compatible with both metals which are available for such purposes.

4.2 Wire conductors

4.2.1 Wire conductors shall be of stranded copper of cross-sectional area not less than 13 mm^2, or their conductivity shall be equal to or greater than that of 13 mm^2 copper wire. Additional recommendations may be found in IEC 60092-352[2].

4.2.2 The size of any strand of a bare copper wire shall be not less than 0,71 mm^2. Insulated copper wires shall have at least 19 strands.

4.2.3 The thickness of metal ribbon or strip shall be equal to or greater than 1 mm.

5 Installation

5.1 General precautionary measure

To minimize side flashes and the induction of high voltage to the craft wiring, lightning conductors in proximity to the craft wiring shall not be routed in parallel to the craft wiring.

5.2 Conductive joints

Conductive joints shall be made and supported so as not to damage the conductors and to provide a conductivity equal to that of the conductor.

5.3 Height of lightning-protective mast

5.3.1 A lightning-protective mast shall be of a height to provide the desired zone of protection in accordance with 5.3.2 to 5.3.4.

5.3.2 For a mast height not exceeding 15 m above the water, the base radius is approximately equal to the mast height, h (see Figure 1).

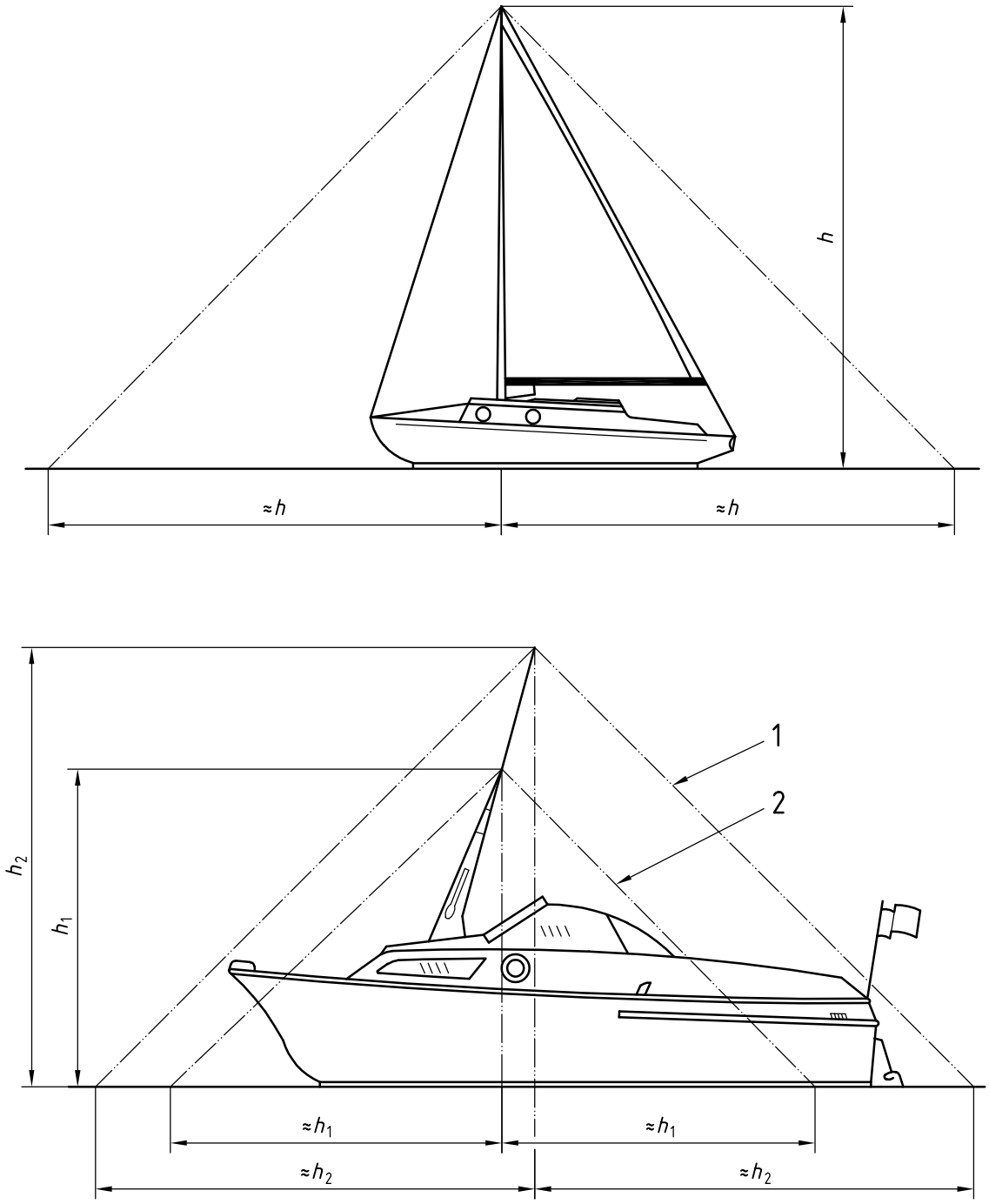
5.3.3 For mast heights over 15 m, the zone of protection is based on the striking distance of the lightning stroke.

Since the lightning stroke may strike any grounded object within the striking distance of the point from which final breakdown to ground occurs, the zone of protection is defined by a circular arc (see Figure 2).

The radius of the arc is the striking distance (30 m). The arc passes through the top of the mast and is tangent to the water. If more than one mast is used, the zone of protection is defined by arcs to all masts.

5.3.4 Additional lightning-protective means shall be erected to form overlapping zones of protection to protect a craft of which the size renders the use of a single mast impractical.

NOTE The protection zone afforded by any configuration of masts or other elevated, conductive and grounded objects can readily be determined graphically. Increasing the height of a mast above the striking distance will not increase the protection zone.



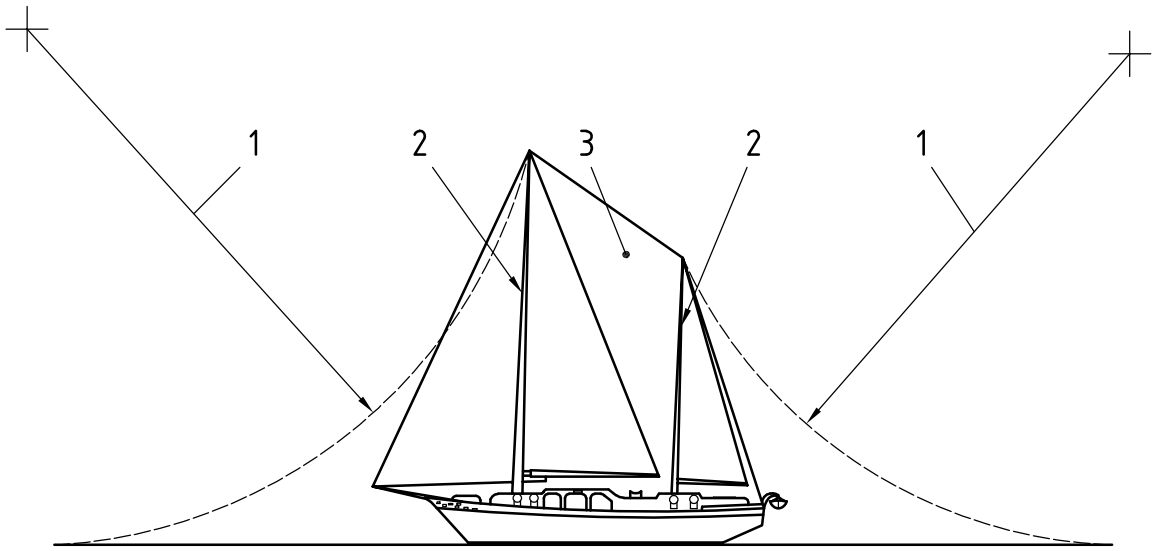
Key

h mast height

1 protection zone with solid antenna extending the height of the lightning-protective mast to protect the entire craft

2 protection zone with lightning-protective mast only

Figure 1 — Craft with a mast not exceeding 15 m above water



Key

1 R 30 m (see 5.3.3)

2 masts in excess of 15 m

3 protection zone inside area outlined by dashed lines

Figure 2 — Craft with mast(s) in excess of 15 m above water

5.4 Alternatives to a lightning-protective mast

5.4.1 If the mast is of non-conducting material, the associated lightning or grounding conductor shall

a) be essentially straight,

b) be securely fastened to the mast,

c) extend at least 150 mm above the mast,

d) terminate in an air terminal, and

e) be led as directly as practicable to the grounding connection as described in 3.2.

5.4.2 A radio antenna or outrigger may serve as a lightning-protective mast, if it meets the requirements of 3.2.

NOTE 1 Non-conducting antenna masts with spirally wrapped conductors are not considered suitable for lightning-protection purposes.

NOTE 2 Because a loading coil presents a high impedance to the flow of lightning current, the portion of an antenna above the bottom of a loading coil is not effective as a lightning-protective mast.

NOTE 3 Although they are partially conductive, carbon fibre materials are regarded as non-conductive (non-metallic) for the purpose of this International Standard.

5.4.3 Small craft without a permanent mast may be protected by means of a temporary lightning-protective mast that may be erected when lightning conditions are observed.

5.4.3.1 The base of the temporary lightning-protective mast shall be located as close to the geometric centre of the craft as possible but can be offset if necessary, providing the protection zone will cover the entire craft when in place.

5.4.3.2 The temporary lightning-protective mast shall be made entirely of metal, or other material if fitted with a down conductor, with a conductivity at least equal to that of a 21 mm^2 copper conductor. It shall be connected to a submerged ground plate of at least 0,1 m^2 total surface area.

5.5 Interconnection of metallic masses

5.5.1 Metallic masses aboard craft which are a permanent part of the craft or are permanently installed within or about the craft, and whose function would not be seriously affected by grounding, shall be incorporated in the lightning-conductor system by interconnection with it or connection through an air gap.

An exception may be made for metallic masses of comparatively small size.

5.5.2 The object of interconnecting the metal parts of a boat with the conductor is to prevent damage from side flashes, especially in the case of rather extensive metal objects that are nearby. The main principle to be observed in the prevention of such damage is to identify on a craft the places where side flashes are most likely to occur and to provide metallic paths for them.

5.5.3 To minimize the flow of lightning discharge current through engine bearings, it may be preferable to connect engine blocks directly to the ground plate rather than to an intermediate point on the lightning conductor.

5.6 Exterior bodies of metal

Metal situated wholly on the exterior of craft shall be electrically connected to the lightning-grounding-conductor system.

Exterior metal bodies on craft include any large masses, such as horizontal guardrails, handrails on cabin tops, smokestacks from galley stoves, electric winches, davits, metal signal masts and metallic hatches.

5.7 Interior bodies of metal

Metal situated wholly in the interior of craft and which at any point comes within 2 m of a lightning conductor shall be electrically connected to this lightning conductor.

Interior bodies of metal include engines, water and fuel tanks, and control rods for steering gear or reversing gear. It is not intended that small metal objects, such as compasses, clocks, galley stoves, medicine chests and other parts of the craft's hardware, be grounded.

5.8 Exterior/interior bodies of metal

5.8.1 Metal which projects through cabin tops, decks or sides of craft above the sheer shall be connected to the nearest lightning conductor at the point where the metal emerges from the craft and shall be grounded at its lower or extreme end within the craft.

5.8.2 Metallic seacocks and through-hull fittings, if connected to the lightning ground system, shall not be connected to the lightning grounding conductor. They shall be connected by lightning bonding conductors to:

a) the lightning ground plate,

b) the lightning grounding strip, or

c) equivalent underwater components as in 5.9.3.

5.9 Lightning ground

5.9.1 A lightning ground for a craft shall consist of any metal surface which is submerged in the water, in any conditions of heel or trim, having an area of at least 0,1 m^2. It shall consist of at least one of the following:

a) an external ground plate or equivalent, located as close to the base of the lightning-protective mast as practicable to minimize any horizontal runs in the lightning grounding conductor;

b) an external grounding strip of copper, copper alloy, stainless steel or aluminum having a minimum thickness of 5 mm and a minimum width of 19 mm.

The edges of the external ground plate or grounding strip should be sharp, exposed and not caulked or faired into the adjoining area.

NOTE A grounding strip approximately 20 mm wide and 4 m long has a substantially greater edge area exposed to the water which, compared to a ground plate, will improve the dissipation of charges.

5.9.2 The grounding strip, if used, shall extend from a point as close to the base of the lightning-protective mast as practicable towards the aft end of the craft where a direct connection to the craft's engine can be made.

5.9.3 Metallic rudder surfaces, struts, metal centreboards and keels, or the ground plate for radio transmitters, may be used for the external ground plate if they meet the surface area and location requirements of 5.9.1 a).

5.9.4 A metal hull itself constitutes an adequate lightning ground plate.

6 Vessels with metal hulls

If there is electrical continuity between metal hulls and lightning-protective masts or other metallic superstructure of adequate height in accordance with Clause 5, no further protection against lightning is necessary.

7 Sailing craft with non-metallic hulls

7.1 Metallic stays and shrouds, metallic masts, and sail tracks on non-metallic masts shall be grounded.

7.2 Grounding of other objects on sailing craft shall be in accordance with Clause 5.

7.3 Multihull craft shall provide a lightning ground in accordance with 5.9 for each hull that has items to be grounded, attached or fitted to it.

8 Engine-powered craft with non-metallic hulls

8.1 Engine-powered craft may be adequately protected by a grounded radio antenna, outrigger, or other grounded lightning-protective mast in compliance with Clause 5, provided the height of the mast conforms to that described for the zone of protection.

8.2 Interconnection and grounding of metallic masses shall be in accordance with Clause 5.

Annex A
(normative)

Owner's manual

A.1 General

If a lightning-protection system is installed on a craft, the owner's manual, ISO 10240[1], shall include information about maintenance of the system and instructions concerning the behaviour of occupants.

A.2 Maintenance

A.2.1 Information about the items in A.2.2 to A.2.4 shall be included in the owner's manual.

A.2.2 Whip-type radio antennas shall not be tied down during a lightning storm if they have been designed as a part of the lightning-protection system.

A.2.3 If a craft has been struck by lightning, compasses, electrical and electronic gear shall be checked to determine whether damage or change in calibration has taken place.

A.2.4 If a craft has been struck by lightning, the lightning-protection system shall be inspected for physical damage, system integrity and continuity to ground.

A.3 Precautions for occupants during a lightning storm

A.3.1 The basic purpose of protection against lightning is to ensure personal safety. Therefore, information about the precautions in A.3.2 to A.3.5 shall be included in the owner's manual.

A.3.2 Occupants shall remain inside a closed craft, as far as practical.

A.3.3 Occupants shall not be in the water. Arms and legs shall not be dangled in the water.

A.3.4 Consistent with safe handling and navigation of the craft, personnel shall avoid making contact with any items connected to a lightning-protection system and especially in such a way as to bridge between these items. For example, it is not recommendable for an operator to be in contact with reversing gear levers and a spotlight control handle at the same time.

A.3.5 Occupants should avoid contact with metal parts of a sailing craft's rigging, spars, fittings and railings.

Bibliography

[1] ISO 10240, *Small craft — Owner's manual*

[2] IEC 60092-352, *Electrical installations in ships — Part 352: Choice and installation of cables for low-voltage power systems*

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