TECHNICAL REPORT

ISO/TR 10134

First edition
2020-05

Small craft — Electrical devices — Established practices for the design, construction and installation of lightning-protection systems

Petits navires — Dispositifs électriques — Pratiques établies pour la conception, la construction et l'installation de dispositifs de protection contre la foudre

Reference number
ISO/TR 10134:2020(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This first edition of this Technical Report cancels and replaces the second edition of the former International Standard (ISO 10134:2003).

The main changes compared to the previous International Standard are as follows:

— transformation into an informative document.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The probability of a lightning strike to a recreational craft 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 Technical Report.

Small craft — Electrical devices — Established practices for the design, construction and installation of lightning-protection systems

1 Scope

This document describes established practices for the design, construction and installation of lightning-protection systems fitted on small craft of hull length up to 24 m.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
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

3.2
air terminal
uppermost part of the lightning-protection system, intended to dissipate the charge or start the lightning ground process

3.3
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

3.4
lightning-protective mast
conductive structure or means for electrical connection of an *air terminal* (3.2) to the *lightning ground plate* (3.3)

3.5
side flash
an arc-over discharge that occurs from the lightning-protection system to any metal object

3.6
lightning bonding conductor
conductor intended to be used for potential equalization between metal bodies and the lightning-protection system

3.7
lightning grounding conductor
conductor installed to connect the *air terminal* (3.2) or the *lightning-protective mast* (3.4) to the *lightning ground plate* (3.3)

3.8
protection zone
zone below a grounded *air terminal* (3.2), mast or overhead ground wire which is substantially immune to direct strokes of lightning

Note 1 to entry: Complete protection from equipment damage or personal injury is not implied.

Note 2 to entry: 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.

4 General

4.1 Protection of persons and small craft from lightning is dependent upon a combination of design and maintenance of equipment and on personnel behaviour. The established practices described in this document can be considered when designing and installing a lightning-protection system. Due to the wide variation in structural design of boats and the unpredictable nature of lightning, specific recommendations cannot be made to cover all cases.

4.2 An adequate lightning grounding conductor or lightning-protective mast is obtained when the entire circuit from the top of the lightning-protective mast to the lightning ground plate has a mechanical strength and a conductivity not less than that of a 21 mm^2 copper conductor, and when the path to ground followed by the conductor is essentially straight. Additional recommendations can be found in IEC 60092-352.

4.3 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. Damage from such side flashes can be prevented by an interconnecting lightning bonding conductor at least equivalent to 13 mm^2 copper (see 5.2.1), provided at all places where the side flashes are likely to occur. Additional recommendations can be found in IEC 60092-352.

4.4 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 practices can 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 4.2 and 6.4.

4.5 Where a lightning-protection system is installed on a craft, it is advised that the owner's manual include the information given in Annex A.

5 Materials

5.1 Corrosion resistance

The material used in a lightning-protective system should 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 using suitable platings or special connectors that are galvanically compatible with both metals which are available for such purposes.

5.2 Wire conductors

5.2.1 Either the wire conductors are of stranded copper of cross-sectional area not less than 13 mm^2, or their conductivity is equal to or greater than that of 13 mm^2 copper wire. Additional recommendations can be found in IEC 60092-352.

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

5.2.3 The thickness of metal ribbon or strip is equal to or greater than 1 mm.

6 Installation

6.1 General precautionary measure

Side flashes and the induction of high voltage to the craft wiring are minimized when lightning conductors in proximity to the craft wiring are not routed in parallel to the craft wiring.

6.2 Conductive joints

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

6.3 Height of lightning-protective mast

6.3.1 The height of lightning-protective masts provides the zone of protection described in 6.3.2 to 6.3.4.

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

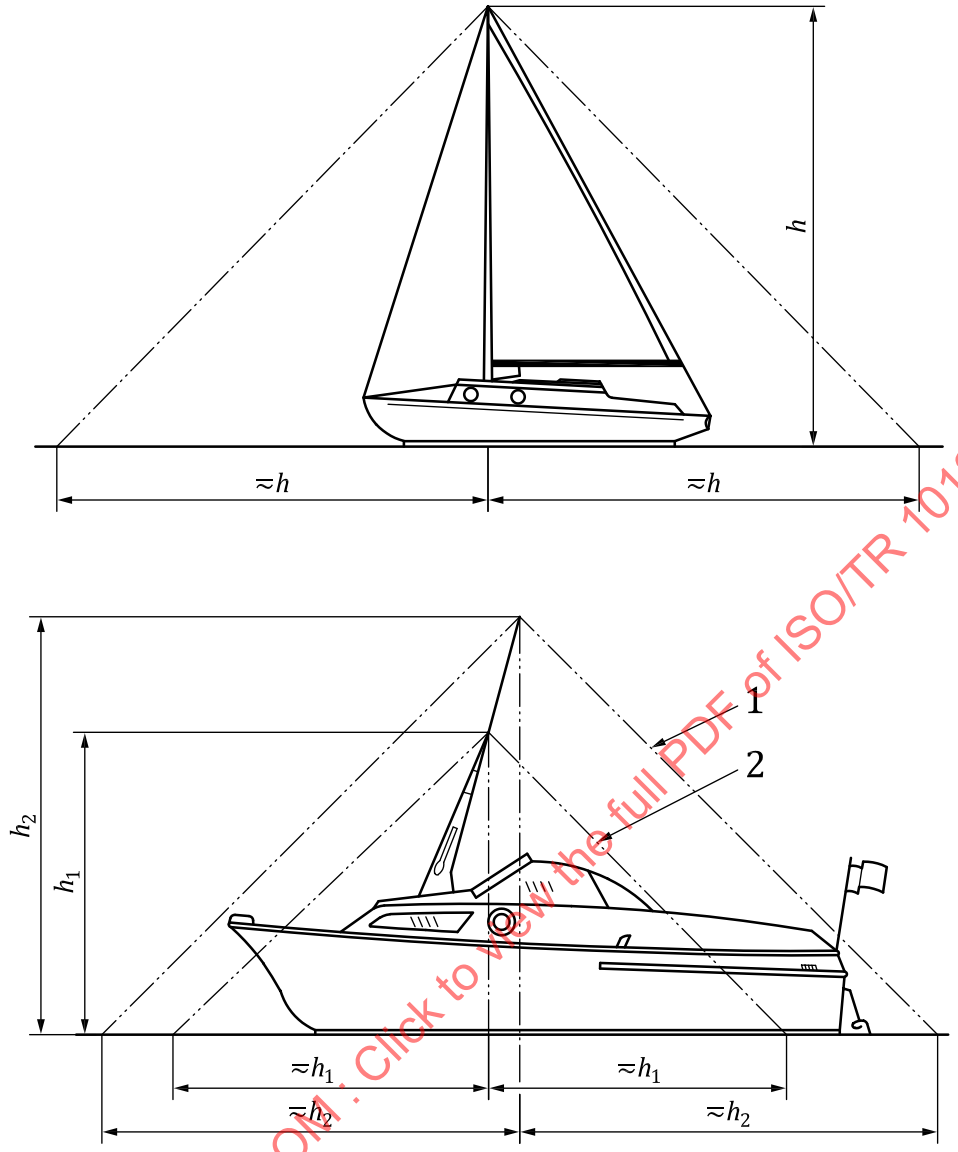
6.3.3 For mast heights exceeding 15 m above the water, the zone of protection is based on the striking distance of the lightning stroke.

Since the lightning stroke can 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.

6.3.4 Additional lightning-protective means are 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 does not increase the protection zone.



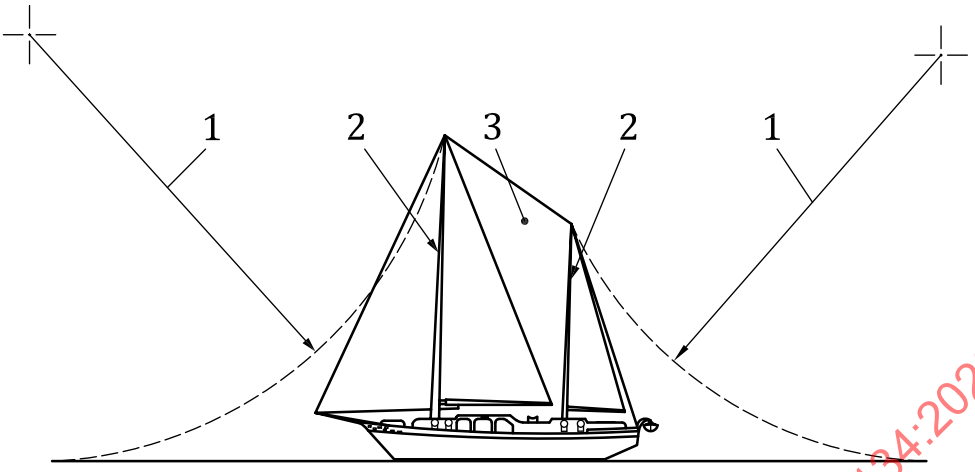
Key

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 6.3.3)

2 masts in excess of 15 m

3 protection zone inside area outlined by dashed lines

Figure 2 — Craft with mast(s) exceeding 15 m above water

6.4 Alternatives to a lightning-protective mast

6.4.1 A mast of non-conducting material can serve as a lightning-protective mast, if the associated lightning or grounding conductor

a) is essentially straight,

b) is securely fastened to the mast,

c) extends at least 150 mm above the mast,

d) terminates in an air terminal, and

e) is led as directly as practicable to the grounding connection as described in 4.2.

6.4.2 A radio antenna or outrigger can serve as a lightning-protective mast, if it meets the practices of 4.2.

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 as 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 document.

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

6.4.3.1 The base of the temporary lightning-protective mast is located as close to the geometric centre of the craft as possible but can be offset if necessary, provided the protection zone covers the entire craft when in place.

6.4.3.2 The temporary lightning-protective mast is 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 is connected to a submerged ground plate of at least 0,1 m^2 total surface area.

6.5 Interconnection of metallic masses

6.5.1 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, are incorporated in the lightning-conductor system by interconnection with it or connection through an air gap.

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

6.5.2 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.

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

6.6 Exterior bodies of metal

Metal attached wholly on the exterior of craft can 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.

6.7 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 can 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.

6.8 Exterior/interior bodies of metal

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

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

a) the lightning ground plate,

b) the lightning grounding strip, or

c) equivalent underwater components as in 6.9.3.