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Small craft — Carbon monoxide (CO) detection systems and alarms

Petits navires — Systèmes de détection et d'alarme du monoxyde de carbone (CO)

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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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).

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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 second edition cancels and replaces the first edition (ISO 12133:2011), which has been technically revised.

The main changes compared to the previous edition are as follows:

— in Clause 2 and throughout the text, dates to normative references have been added;

— in Clause 3, definitions have been updated;

— in 5.1.5, a low battery alarm requirement has been added;

— 5.2.3, design operating temperature range, has been added;

— requirements have been clarified in 5.3.2;

— 5.3.3 has been updated to require CO detectors without self-contained batteries to be connected to the continuously energized side of the battery switch;

— in 6.3, marking requirements have been added;

— in Figure 1 (beta curve chart) the 30 ppm line reference has been updated;

— in Figure 1, the Key has been updated;

— in Annex A, the other factors during boat operation that can affect carbon monoxide concentration have been clarified;

— EN 50291 has been moved to the Bibliography.

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.

Small craft — Carbon monoxide (CO) detection systems and alarms

1 Scope

This document specifies requirements for the design, construction and installation of carbon monoxide detection and alarm systems in small craft.

Annex A provides essential educational material about carbon monoxide relative to small craft, and recreational boating recommendations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 13297:2020, *Small craft — Electrical systems — Alternating and direct current installations*

IEC 60529:2013/Corr1:2019, *Degrees of protection provided by enclosures (IP Code)*

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
carbon monoxide
CO
gas formed by the combination of one atom of carbon and one atom of oxygen

Note 1 to entry: In its chemical formula, C stands for carbon and O for oxygen. For the purposes of this document, the CO level is always expressed in terms of mass fraction of CO in air.

3.2
carboxyhaemoglobin
COHb
compound formed when c*arbon monoxide* (3.1) combines with haemoglobin

3.3
% COHb
degree to which the oxygen carrying capacity of blood is impeded by the union of c*arbon monoxide* (3.1) to the haemoglobin in blood, expressed as a percentage

3.4
enclosed accommodation compartment
contiguous space, surrounded by permanent structure, that contains all of the following:

a) designated sleeping accommodations,

b) a galley area with sink, and

c) a head compartment

Note 1 to entry: A cuddy intended for gear storage and open passenger cockpits, with or without canvas enclosures, are not considered to be enclosed accommodation compartments.

3.5
craft
small craft
recreational boat, and other watercraft using similar equipment, of up to 24 m length of hull (L_H)

[SOURCE: ISO 8666:2020, 3.15]

4 Symbols

β (beta) arbitrary variable name chosen to represent the mathematical calculation of the absolute worst case of predicted % COHb levels in a typical individual exposed to the factors [mass fraction (mg/kg) of carbon monoxide level and minutes of exposure to that CO level] used in that calculation.

5 Requirements

5.1 Design and construction

5.1.1 Detectors shall meet the requirements of relevant national standards (e.g. UL 2034 or EN 50291-2:2019).

5.1.2 An audible alarm shall be provided.

If detectors employing a COHb level algorithm, or other integrating alarm structures, include a switch to mute only the audible alarm, then warnings or other means shall be provided to protect such a switch from casual use. The switch shall not reset the detector and shall not mute the alarm for more than 6 min.

5.1.3 There shall be no power switch on the detector.

5.1.4 A non-mechanical indicator, e.g. some type of visual electrical indicator (lamp, LED, LCD, etc.), shall be provided on the detector to indicate that it is in operation.

5.1.5 A circuit self-check shall be provided that shall also give alarms for an electrically defective sensor or low battery condition. A testing procedure or test switch shall be provided for checking the alarm circuitry.

5.1.6 Detectors shall be designed and marked as drip proof or watertight in accordance with IP rating 42, as specified in IEC 60529:2013/Corr1:2019.

5.1.7 Detectors shall be powered by the craft's electrical system, or by a self-contained battery.

5.2 Performance specifications

5.2.1 The detector shall be tested to the relevant national standard including the following:

— β (beta) = 10 % maximum;

— an alarm condition shall occur at some point within the shaded area of the beta curve as illustrated in Figure 1.

5.2.2 β is calculated from the following expression:

$$\beta = 218 \times \left(0{,}000\,3 + \frac{w_{co}}{1\,316} \right) \times \left(1 - e^{-t/96{,}879\,2} \right) \quad (1)$$

where

w_{co} is the mass fraction of CO, in mg/kg (ppm);

e is the base natural logarithm, approximately equal to 2,718 28;

t is the time of exposure, in minutes.

NOTE For reference purposes, the β (beta) formula solved for t or w_{co} is as follows:

$$w_{co} = \frac{6{,}036\,7\beta}{1 - e^{-t/96{,}879\,2}} - 0{,}394\,8 \quad \text{and} \quad t = -96{,}879\,2 \times \ln\left[1 - \frac{\beta}{0{,}065\,4 + 0{,}166 w_{co}} \right]. \quad (2)$$

5.2.3 The design operating temperature range of CO detectors shall be -40 °C to 70 °C.

5.3 Installations

5.3.1 A carbon monoxide detection system shall be installed on all craft with an enclosed accommodation compartment(s).

5.3.2 Detectors shall be located to monitor the atmosphere in a continuous cabin space and additionally in each sleeping space separated by solid bulkheads/structure and permanent doors/partitions.

NOTE Sleeping spaces separated only by curtains do not need additional CO detector(s).

5.3.2.1 The detector shall be mounted and located to avoid areas subject to physical damage, including harm from rain, water or sunlight, and dilution of sampled air (e.g. near hatches, ports or forced ventilation openings), and inadequate natural air circulation, (e.g. in corners).

5.3.2.2 The d.c. electrical system of the detector system shall be installed in accordance with ISO 13297:2020, except for detectors powered by a self-contained battery.

5.3.3 If a circuit breaker is installed, it shall include a block or other multi-step means to prevent it from being inadvertently turned off.

CO detectors without a self-contained battery shall be connected to the continuously energized side of the battery switch.

5.3.4 The craft's manufacturer shall draw attention to the hazards of carbon monoxide when boating, as well as provide instructions on what actions should be taken when the CO alarm sounds. Craft manufacturers should reference the information provided in Annex A.

5.4 Instructions

Instructions covering the installation and operation shall be provided with each detector. The following information shall be included in the instructions:

— mounting location requirements consistent with the requirements in 5.3;

— actions to be taken when the alarm system sounds, wherein the order of action is evacuate, ventilate, investigate, and take corrective action;

— the manufacturer's service policy;

— the manufacturer's recommendation for overcurrent protection shall specify the current rating and type of overcurrent protection device in the connected branch circuit;

— if a fuse is used, the fuse current rating shall be permanently marked to be visible if the fuse is replaced;

— the manufacturer's recommendation for operational testing and frequency for such testing, in accordance with Clause 5;

— general educational material about carbon monoxide;

— the detector's performance specifications, in accordance with this document;

— information on the detector's ability to sense only the air in the vicinity of the detector's sensing element.

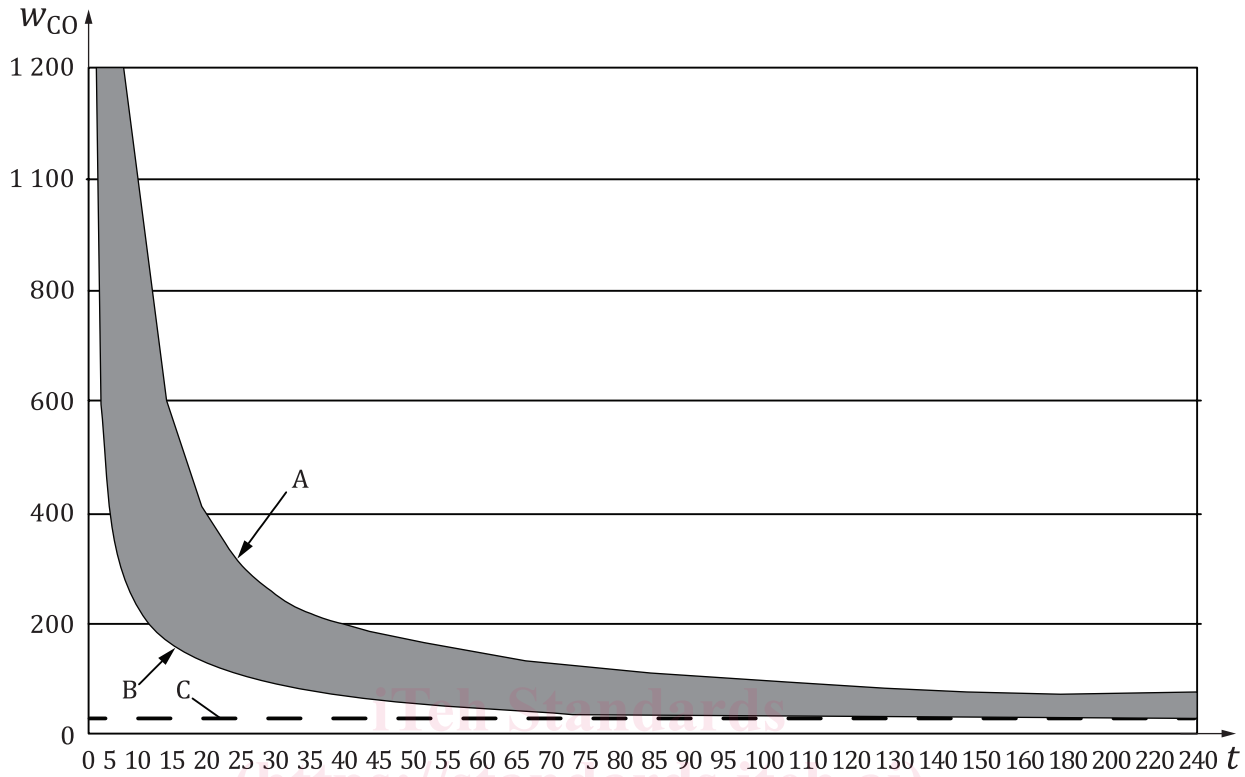
6 Markings

6.1 Detectors shall be marked with "Marine carbon monoxide alarm" or equivalent, as tested to the relevant national standard.

6.2 Detectors that have been certified by a certification body shall be marked with the name of the certifying body. The markings shall be clearly visible as installed.

NOTE These markings are in addition to markings required under the relevant national standard.

6.3 Detectors shall be marked with a “Replace by date” or “Replace by XX months after retail sale”, as determined by the manufacturer.



Key

t	time (min)
w_{co}	mass fraction of CO in mg/kg (ppm)
A	10 % COHb curve
B	2,5 % COHb curve
C	30 mg/kg (ppm)

NOTE 1 This figure is for illustrative purposes only.

NOTE 2 The β formula given in 5.2.2 is used to determine β.

Figure 1 — Beta curve for 2,5 % to 10 % COHb level — CO mass fraction in mg/kg (ppm) vs. time in minutes

Annex A
(informative)

Educational information about carbon monoxide

A.1 General

This annex provides essential educational material about carbon monoxide relative to small craft, and recreational boating recommendations.

Carbon monoxide can accumulate in interior spaces and exterior areas. Carbon monoxide accumulation is affected by a multitude of variables (e.g. boat geometry, hatch, window and door openings, ventilation openings, proximity to other structures, swim platforms, canvas enclosures, location of exhaust outlets, vessel attitude, wind direction, boat speed, boat system performance and maintenance).

This annex discusses many of these variables and enables the reader to better understand some of the more predictable effects. However, this annex is limited in that it cannot cover all conceivable variables, and the reader is cautioned not to rely exclusively on it to prevent the accumulation of carbon monoxide.

A.2 Properties and characteristics of carbon monoxide

Carbon monoxide (CO) is a colourless, odourless and tasteless gas that weighs about the same as air. It cannot be expected to rise or fall like some other gases because it distributes itself throughout the space. Do not rely on the sense of smell or sight of other gases to detect CO as it diffuses in the air much more rapidly than easily detectable vapours (i.e. visible and aromatic vapours).

A.3 What makes carbon monoxide?

Carbon monoxide is produced any time a material containing carbon burns, such as petrol, natural gas, oil, propane, coal or wood. Common sources of CO are internal combustion engines and open flame appliances such as, but not limited to,

— propulsion engines,

— auxiliary engines (gensets),

— cooking ranges,

— central heating plants,

— space heaters,

— water heaters,

— fireplaces, and

— charcoal grills.

The carbon monoxide component of diesel exhaust is extremely low relative to the carbon monoxide level found in petrol engine exhaust.