IEC 60533

Edition 3.0 2015-08

INTERNATIONAL STANDARD

Electrical and electronic installations in ships – Electromagnetic compatibility (EMC) – Ships with a metallic hull

IEC 60533:2015-08(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
More than 60 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

IEC 60533

Edition 3.0 2015-08

INTERNATIONAL STANDARD

Electrical and electronic installations in ships – Electromagnetic compatibility (EMC) – Ships with a metallic hull

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.100; 33.100.10; 47.020

ISBN 978-2-8322-2849-4

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ELECTRICAL AND ELECTRONIC INSTALLATIONS IN SHIPS – ELECTROMAGNETIC COMPATIBILITY (EMC) – SHIPS WITH A METALLIC HULL

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60533 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

This third edition cancels and replaces the second edition, published in 1999. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

– Introduction has been supplemented;
– scope and title have been modified to limit the application of the standard to installations in ships with metallic hulls only;
– the normative references have been updated;
– further explanation for *in-situ* testing has been given in 5.1;
– numbering of CISPR-Standards in Tables 1, 2 and 3 has been updated;

– title of Annex B has been changed;
– requirements on cable routing in Annex B have been amended;
– new Annex C EMC test report has been added.

The text of this standard is based on the following documents:

FDIS	Report on voting
18/1460/FDIS	18/1471/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

INTRODUCTION

Electrical installations of ships with electric and/or electronic systems need to operate under a wide range of environmental conditions.

The control of undesired electromagnetic emission ensures that no other device on board will be unduly influenced by the equipment under consideration. Suitable limits are specified.

On the other hand, the equipment needs to function without degradation in the normal electromagnetic environment. The limit values for immunity, specified in this International Standard, have been chosen under this assumption. Equipment which is tested and installed in accordance with this International Standard meets the relevant IMO requirements. Special risks, for instance lightning strikes, transients from the operation of circuit breakers and electromagnetic radiation from radio transmitters are also covered.

Complex electric and/or electronic systems require EMC planning in all phases of design and installation, considering the electromagnetic environment, any special requirements and the equipment performance.

This third edition of IEC 60533 is applicable to electromagnetic compatibility of all electrical and electronic installations in ships with metallic hull.

It is based on the assumption that the ship is constructed in such a way that metallic hull and structure parts will significantly attenuate electromagnetic disturbance from the outer deck environment to the inner deck environment and vice versa.

ELECTRICAL AND ELECTRONIC INSTALLATIONS IN SHIPS – ELECTROMAGNETIC COMPATIBILITY (EMC) – SHIPS WITH A METALLIC HULL

1 Scope

This International Standard specifies minimum requirements for emission, immunity and performance criteria regarding electromagnetic compatibility (EMC) of electrical and electronic equipment for ships with metallic hull. Additional or divergent requirements for ships with non-metallic hull will be given in a future International Standard (IEC 62742).

This International Standard assists in meeting the relevant EMC requirements as stated in SOLAS 74, Chapter IV, Regulation 6 and Chapter V, Regulation 17. Reference to this International Standard is made in IMO Resolution A.813(19).

The normative part of this International Standard has been prepared as a product family EMC standard.

This International Standard further gives guidelines and recommendations on the measures to achieve EMC in the electrical and electronic installations of the following equipment groups:

a) group A: maritime navigation and radio communication equipment and systems;
b) group B: power generation and conversion equipment;
c) group C: equipment operating with pulsed power;
d) group D: switchgear and controlgear;
e) group E: intercommunication and signal processing equipment and control systems;
f) group F: non-electrical items and equipment;
g) group G: integrated systems.

The basic EMC standard for groups A and C is IEC 60945. The EMC requirements according to IEC 60945 apply additionally for

- bridge mounted equipment;
- equipment in close proximity to receiving antennas;
- equipment capable of interfering with the safe navigation of the ship and with radio communication.

Effects on humans, like exposure to electromagnetic fields, and basic safety requirements such as protection against electric shock and dielectric strength tests for equipment are not within the scope of this International Standard.

2 Normative references

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

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at: www.electropedia.org)

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

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-4-16, *Electromagnetic compatibility (EMC) – Part 4-16: Testing and measurement techniques – Test for immunity to conducted common mode disturbances in the frequency range 0 Hz to 150 kHz*

IEC 61000-6-1, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments*

IEC 61000-6-3, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*

CISPR 16-1-2, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*

CISPR 16-1-4, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*

CISPR 16-2-1, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*

CISPR 16-2-3, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*

IACS E10, *Test specification for type approval*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 and the following apply.

3.1
electromagnetic compatibility
EMC
ability of an equipment or system to function satisfactorily in its *electromagnetic environment* without introducing intolerable *electromagnetic disturbances* to anything in that environment

[SOURCE: IEC 60050-161:1990, 161-01-07)

3.2
electromagnetic influence
effect of electromagnetic quantities on electrical and electronic circuits, equipment, systems or humans

3.3
electromagnetic interference
EMI
degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance

Note 1 to entry: In French, the terms “perturbation électromagnétique” and “brouillage électromagnétique” designate respectively the cause and the effect, and should not be used indiscriminately.

Note 2 to entry: The English words "interference" and "disturbance" are often used indiscriminately.

[SOURCE: IEC 60050-161:1990, 161-01-06)

3.4
degradation
<of performance> undesired departure in the operational performance of any device, equipment or system from its intended performance

Note 1 to entry: The term "degradation" can apply to temporary or permanent failure.

[SOURCE: IEC 60050-161:1990, 161-01-19]

3.5
loss of function
loss of function of a device beyond that permissible and where the function can be restored only by technical measures

Note 1 to entry: A special case of loss of function is destruction.

Note 2 to entry: Loss of function may be permanent or temporary:

– technical measures to correct permanent loss require the use of tools or spare parts;

– technical measures to correct temporary loss require simple operator actions such as resetting a computer or reswitching.

3.6
electromagnetic disturbance
any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

Note 1 to entry: An electromagnetic disturbance may be an electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

[SOURCE: IEC 60050-161:1990, 161-01-05]

3.7
emitter
<of electromagnetic disturbance> device, equipment or system which gives rise to voltages, currents or electromagnetic fields that can act as electromagnetic disturbance

[SOURCE: IEC 60050-161:1990, 161-01-23]

3.8
susceptible device
device, equipment or system whose performance can be degraded by an electromagnetic disturbance

[SOURCE: IEC 60050-161:1990, 161-01-24]

3.9
emission
electromagnetic emission
phenomenon by which electromagnetic energy emanates from a source

[SOURCE: IEC 60050-161:1990, 161-01-08]

3.10
immunity
ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[SOURCE: IEC 60050-161:1990, 161-01-20]

3.11
coupling
interaction of circuits between which energy can be transferred

3.12
insertion loss
logarithmic ratio of the magnitude of the power which a load picks up when fed directly from the power source, to the magnitude of the power which the load picks up after inserting a two-port network (for example a filter) between source and load

3.13
return loss
a
logarithmic ratio of the reciprocal value of the reflection factor:

$$a = 20 \times \lg \frac{1}{r};$$

where

r is the ratio of return wave to forward wave

Note 1 to entry: $r = 0$, $a = \infty$, if the impedance of the protection circuit is matched to the wave impedance of the connected cable.

3.14
EMC analysis
compilation and interpretation of EMC data to determine the degree of influence with electrical devices

3.15
electromagnetic interference matrix
EMI matrix
structure where emitters are set against susceptible devices

Note 1 to entry: At the crosspoints of lines and columns the extent of electromagnetic interference is noted.

3.16
system
set of devices and/or components which interact according to a design

EXAMPLE Hardware (controlling system, controlled system), software, human interaction.

Note 1 to entry: The total ship with its equipment may be considered to be a system.

3.17
subsystem
single device and/or component intended to perform a given function, combining a number of sub-units, electrically and mechanically

3.18
integrated system
combination of separate systems intended to perform a given function

EXAMPLE Integrated cargo monitoring system with sensors and equipment in different zones.

3.19
ground
earth
point, plane, or surface designated as the zero potential (nominally) and serving as a common reference potential for electrical or electronic equipment

EXAMPLE Ship's metallic structure and all other metal parts conductively interconnected.

Note 1 to entry: For EMC purposes, interconnections between metal parts equalize the different potentials and require a low impedance in the frequency range considered. The frequency range considered includes the operating as well as the disturbing frequencies. This frequency range and the physical size of the electrical device determine the achievable equalization of potentials and thus the effectiveness of the grounding. The ground (earth) does not in all cases meet the personnel safety requirements of the protective earth.

Note 2 to entry: For ships with a non-metallic structure, all conductively interconnected metal parts (including earth/ground plate if existing) form the common ground (earth).

3.20
grounding
establishing of potential difference minimizing electrical connections

Note 1 to entry: The term "bonding" is normally used for the act of creating a conductive path between two conductive surfaces.

Note 2 to entry: The term "earthing" (US, CA: "grounding") is normally used for measures to prevent the danger of an electric shock by connection to earth. Additionally, "earthing/grounding" are used for the act of creating a return path to the power source.

3.21
type test
test for a sample item of equipment to ascertain that it meets the requirements according to this International Standard

3.22
port
defined interface of an equipment with the external electromagnetic environment through which disturbances may be received or emitted

Note 1 to entry: Conductive interfaces may also consist of cables, bond straps or mechanical interfaces such as metallic pipes and mounting provisions.

Note 2 to entry: No testing needs to be performed on the ground port.

Note 3 to entry: See Figure 1.

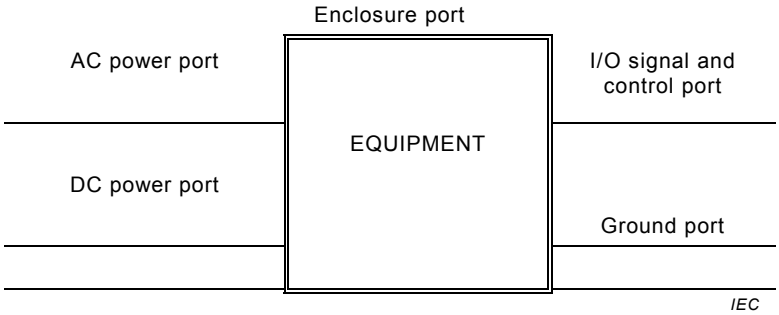

Figure 1 – Examples for ports

3.23
zone
area characterized by sensitive and/or disturbing devices located therein

SEE: Figure 2.

3.24
deck and bridge zone
area in close proximity to receiving and/or transmitting antennas and the wheelhouse as well as the control rooms, characterized by equipment for intercommunication, signal processing, radio communication and navigation, auxiliary equipment and large openings in the metallic structure

SEE: Figure 2.

3.25
general power distribution zone
area characterized by normal consumers

SEE: Figure 2.

3.26
special power distribution zone
area characterized by propulsion systems, bow thrusters, etc.

SEE: Figure 2.

Note 1 to entry: The generated emissions exceed the limits given in Table 3.

3.27
accommodation zone
area characterized by equipment that is non-essential for the ship’s purpose

SEE: Figure 2.

EXAMPLE Crew quarters; offices; mess; lounges; passenger cabins.

Note 1 to entry: Precautions should be taken for a sufficient decoupling of the accommodation zone from all other zones.

3.28
normal consumers
equipment for ship's operation