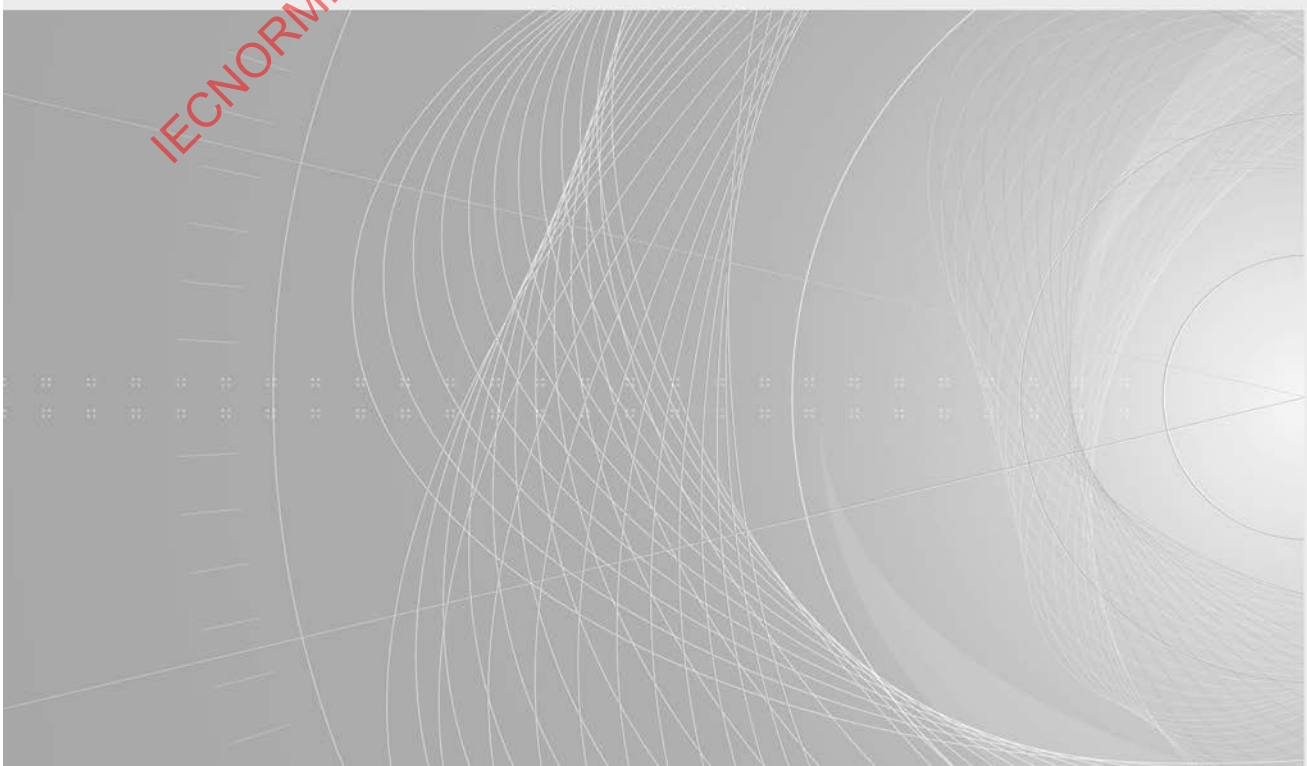
IEC 60092-101

Edition 5.0 2018-10

INTERNATIONAL STANDARD

Electrical installations in ships –
Part 101: Definitions and general requirements



IEC 60092-101:2018-10(en)

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

Tel.: +41 22 919 02 11
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 - webstore.iec.ch/advsearchform
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 It also gives information on projects, replaced and withdrawn publications.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 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 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: sales@iec.ch.

IEC 60092-101

Edition 5.0 2018-10

INTERNATIONAL STANDARD

Electrical installations in ships – Part 101: Definitions and general requirements

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ICS 01.040.47; 47.020.60

ISBN 978-2-8322-6079-1

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ELECTRICAL INSTALLATIONS IN SHIPS –

Part 101: Definitions and general requirements

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 60092-101 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

This fifth edition cancels and replaces the fourth edition published in 1994 and Amendment 1:1995. This edition constitutes a technical revision.

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

a) the applicability of the standard has been changed to 1 000 V AC and 1 500 V DC:
b) the table for design temperature has been simplified;
c) the clause regarding power supply system characteristics has been rewritten;
d) information regarding pollution degree has been added in the clause regarding clearance and creepage distances;
e) a clause regarding environmental impact has been added;

f) the clause regarding classification test for materials has been deleted;

g) the annex regarding flame-retardant test for cables has been deleted;

h) the annex regarding test on bunched wires or cables under fire conditions has been deleted.

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

FDIS	Report on voting
18/1617/FDIS	18/1631/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.

A list of all parts in the IEC 60092 series, published under the general title *Electrical installations in ships*, can be found on the IEC website.

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 publication may be issued at a later date.

INTRODUCTION

The IEC 60092 series includes international standards for electrical installations in sea-going ships, incorporating good practice and coordinating, as far as possible, existing rules. These standards form a code of practical interpretation and amplification of the requirements of the International Convention for the Safety of Life at Sea, a guide for future regulations which may be prepared and a statement of practice for use by ship-owners, shipbuilders and appropriate organizations.

ELECTRICAL INSTALLATIONS IN SHIPS –

Part 101: Definitions and general requirements

1 Scope

This part of IEC 60092 is applicable to electrical installations for use in ships.

The definitions and general requirements given in this part are applicable, unless otherwise indicated, to other parts of the IEC 60092 series.

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.

IEC 60034-30-1, *Rotating electrical machines – Part 30-1: Efficiency classes of line operated AC motors (IE code)*

IEC 60079 (all parts), *Explosive atmosphere*

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

IEC 60092-305, *Electrical installations in ships – Part 305: Equipment – Accumulator (storage) batteries*

IEC 60092-504:2016, *Electrical installations in ships – Part 504: Automation, control and instrumentation*

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

IEC 60533, *Electrical and electronic installations in ships – Electromagnetic compatibility (EMC) – Ships with a metallic hull*

IEC 60664-1, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60695-11-5, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 61439-1:2011, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

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:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

NOTE Definitions included in this part are those having general application in IEC 60092. Definitions applying to particular apparatus or equipment which are only included within a single part of IEC 60092 are separately defined in that part only.

3.1
appropriate authority
governmental body and/or classification society whose rules a ship is required to comply with

3.2
ocean-going ship
ship not exclusively employed in the navigation of rivers or inland waters

3.3
essential services
services essential for the navigation, propulsion, steering or manoeuvring of the ship, or for the safety of human life, or for special characteristics of the ship (for example special services)

3.4
accessory
device, other than a luminaire (see IEC 60092-306), associated with the wiring and current-using appliances of an installation

EXAMPLE Switch, fuse, plug, socket-outlet, lampholder or junction box.

3.5
bond
connection of non-current-carrying parts to ensure continuity of electrical connection, or to equalize the potential between parts comprising, for example, the armour or lead sheath of adjacent length of cable, the bulkhead, etc.

EXAMPLE Bulkhead and cables in a radio-receiving room.

3.6
earth
general mass of the metal hull of the ship

Note 1 to entry: In the USA, "ground" is used instead of "earth".

3.7
earthed
connected to the general mass of the hull of the ship in such a manner as will ensure at all times an immediate discharge of electrical energy without danger

Note 1 to entry: A conductor is said to be "solidly earthed" when it is electrically connected to the hull without a fuse-link, switch, circuit-breaker, resistor, or impedance, in the earth connection.

Note 2 to entry: In the USA. "grounded" is used instead of "earthed".

3.8
basic insulation
insulation of hazardous-live-parts which provides basic protection

Note 1 to entry: This concept does not apply to insulation used exclusively for functional purposes

[SOURCE: IEC 60050-195:1998, 195-06-06]

3.9
supplementary insulation
independent insulation applied in addition to basic insulation, for fault protection

[SOURCE: IEC 60050-195:1998, 195-06-07]

3.10
double insulation
insulation comprising both basic insulation and supplementary insulation

[SOURCE: IEC 60050-195:1998, 195-06-08]

3.11
reinforced insulation
insulation of hazardous-live-parts which provides a degree of protection against electric shock equivalent to double insulation

Note 1 to entry: Reinforced insulation may comprise several layers which cannot be tested singly as basic insulation or supplementary insulation

[SOURCE: IEC 60050-195:1998, 195-06-09]

3.12
live
qualifies a conductive part intended to be energized in normal operation

Note 1 to entry: A live part may be temporarily dead when it is not energized. A neutral conductor is considered as live but earthing conductors are not.

[SOURCE: IEC 60050-151:2001, 151-15-60]

3.13
maritime distribution board
switchgear and controlgear assembly which is supplied by a main or emergency switchboard, or distribution boards and is used to distribute and control energy to other distribution boards, final distribution boards or final sub circuits.

Note 1 to entry: The definition of section board has been replaced by distribution board.

3.14
final subcircuit
that portion of a wiring system extending beyond the final overcurrent protective device of a board

3.15
point
<wiring> any termination of the fixed wiring intended for the attachment of a luminaire or for connecting to the supply a current-using appliance

3.16
extra low voltage
voltage not exceeding the relevant voltage limit of extra low voltage (ELV)-band specified in IEC 61140

Note 1 to entry: The voltage band for ELV in IEC 61140 is equal or less than 50 V AC and equal and less than 120 V DC.

[SOURCE: IEC 60050-826:2004, 826-12-30; modified]

3.17
materials

3.17.1
arc-resistant material
material is arc-resistant when it is not excessively damaged by the action of the repeated arcs that may occur at its surface under actual duty conditions

3.17.2
flame retardant material
material whereby flaming combustion is slowed, terminated or prevented

3.17.3
fire resistant material
material able to withstand fire or give protection from it for a period of time

3.17.4
non-combustible material
material not capable of undergoing combustion under specified conditions

Note 1 to entry: A material is classified as being non-combustible even if it is capable of combustion, provided that its heat of combustion is less than a defined amount.

3.18
spaces

3.18.1
accomodation spaces
spaces used for public spaces, corridors, lavatories, cabins, offices, crew quarters, barber shops, isolated pantries and lockers, and similar spaces

3.18.2
cargo spaces
spaces used for cargo (including liquid cargo tanks) and trunks to such spaces

3.18.3
hazardous area
area in which an explosive atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of electrical equipment

Note 1 to entry: IEC 60079-10-1 specifies requirements to classification of hazardous areas in potential explosive gas atmospheres (see also IEC 60050-426:2008, 426-03-03, 426-03-04 and 426-03-05).

Note 2 to entry: For tankers, see IEC 60092-502.

Note 3 to entry: Hazardous spaces are also referred to as dangerous spaces.

[SOURCE: IEC 60050-426:2008, 426-03-01; modified]

3.18.4
machinery spaces
all spaces containing propelling machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air-conditioning machinery, and similar spaces; and trunks to such spaces

3.18.5
public spaces
portions of the accommodation used for halls, dining-rooms, lounges, and similar permanently enclosed spaces

3.18.6
service spaces
spaces used for galleys, main pantries, stores (except isolated pantries and lockers), mail and specie rooms, workshops other than those forming part of machinery spaces, and similar spaces and trunks to such spaces

3.18.7
main vertical zones
sections into which the hull, superstructure and deck houses are divided by fire-resisting bulkheads and decks.

Note 1 to entry: The mean length of these on any deck does not in general exceed 40 m.

3.18.8
control stations
spaces in which the ship's radio or main navigating equipment or the emergency source of power is located, or where the fire recording or fire control equipment is centralized

3.18.9
degree of protection of enclosure
IP (abbreviation)
classification according to IEC 60529 preceded by the symbol IP applied to the enclosure of electrical apparatus to provide:

– protection of persons against contact with, or approach to, live parts and against contact with moving parts inside the enclosure,
– protection of the electrical apparatus against ingress of solid foreign objects, and
– where indicated by the classification, protection of the electrical apparatus against harmful ingress of water

[SOURCE: IEC 60050-426:2008, 426-04-02, modified]

3.19
voltage

3.19.1
voltage tolerance
maximum departure from nominal user voltage during normal operating conditions, excluding transient and cyclic voltage variations

Note 1 to entry: Voltage tolerance is a steady state tolerance and includes voltage drop in cables and voltage regulator characteristics. It also includes variations due to environmental conditions.

3.19.2
voltage unbalance tolerance
difference between the highest and lowest phase to phase voltage

3.19.3
voltage cyclic variation deviation
periodic voltage deviation (max. to min. RMS values) of the nominal voltage, such as might be caused by regularly repeated loading

SEE Voltage cyclic variation = $\frac{\pm (U_{max} - U_{min}) \times 100}{2\,U_{nominal}}$ %

3.19.4
voltage transient
sudden change in voltage (excluding spikes) which goes outside the nominal voltage tolerance limits and returns to and remains inside these limits within a specified recovery time after the initiation of the disturbance

Note 1 to entry: The recovery time is measured in seconds.

3.20
waveform

3.20.1
total harmonic distortion
THD
ratio of the RMS value of the sum of all the harmonic components up to a specified order (recommended notation "H") to the RMS value of the fundamental component

$$\text{THD} = \sqrt{\sum_{h=2}^{h=H} \frac{(Q_h)^2}{(Q_1)^2}}$$

where

Q represents either current or voltage;

Q_1 is the RMS value of the fundamental component;

h is the harmonic order;

Q_h is the RMS value of the harmonic component of order h;

H is 50 for the purpose of the compatibility levels in this document

Note 1 to entry: THD takes account of harmonics only. For any case where interharmonics are included, reference is made to A.3.1 of IEC 61000-2-4:2002.

[SOURCE: IEC 61000-2-4:2002, 3.2.7, modified – The definition has been rephrased and the expression "of IEC 61000-2-4:2002" has been added in the note to entry.]

3.20.2
single harmonic content
ratio of the effective RMS value of that harmonic to the RMS value of the fundamental expressed in per cent

3.21
frequency

3.21.1
frequency tolerance
maximum deviation from nominal frequency during normal operation conditions excluding transient and cyclic frequency variations

Note 1 to entry: Frequency tolerance is a steady state tolerance and includes variations caused by loads and governor characteristics. It also includes variations due to environmental conditions.

3.21.2
frequency cyclic variation
periodic deviation in frequency during normal operation such as might be caused by regularly repeated loading

$$\text{Frequency cyclic variation} = \frac{\pm (f_{\max} - f_{\min}) \times 100}{2\, f_{\text{nominal}}} \%$$

3.21.3
frequency transient
sudden change in frequency which goes outside the frequency tolerance limits and returns to and remains inside these limits within a specified recovery time after the initiation of the disturbance

Note 1 to entry: The recovery time is measured in seconds.

3.22
time

3.22.1
voltage transient recovery time
time elapsed from exceeding the normal tolerance until the voltage recovers and remains within the normal tolerance limits

3.22.2
frequency transient recovery time
time elapsed from exceeding the normal tolerance until the frequency recovers and remains within the frequency tolerance limits

4 General requirements and conditions

4.1 General

This clause contains conditions and requirements which are common to all apparatus and installations.

NOTE Attention is drawn to the requirements of the International convention for the safety of life at sea (SOLAS).

4.2 Applicability of the IEC 60092 series to AC and DC

Except where a specific statement is made to the contrary, all parts of the IEC 60092 series are equally applicable to AC and DC installations. For voltages above 1 000 V AC and 1 500 V DC additional requirements will be found in IEC 60092-503.

4.3 Acceptance of substitutes or alternatives

Where, in the IEC 60092 series, any special type of apparatus, construction or arrangement is specified, the use of any other apparatus, construction or arrangement is permissible, provided it is demonstrated to give an equivalent level of safety, performance and reliability.

4.4 Provisions for maximum load

All conductors, switchgear and accessories shall be of such size as to be capable of carrying, without their respective ratings being exceeded, the current which can normally flow through them. They shall be capable of carrying anticipated overloads and transient currents, for example the starting currents of motors, without damage or reaching abnormal temperatures.

4.5 Additions and alterations

An addition or alteration, temporary or permanent, shall not be made to an existing installation until it has been definitely ascertained that the ratings and the condition of existing accessories, conductors, switchgear, etc., affected are adequate for the new situation.

Special attention is drawn to those factors affecting the existing system design such as current-carrying capacity, short-circuit level, voltage drop, harmonics, stability and proper discrimination of the protective devices.

Any addition or alteration, temporary or permanent, made to an existing installation shall be properly documented and the documentation retained for future reference.

4.6 Environmental conditions

4.6.1 General

Electrical equipment shall operate satisfactorily under various anticipated environmental conditions.

Environmental conditions are influenced by a number of variables such as climatic conditions, biological conditions, conditions dependent upon chemically and mechanically active substances, mechanical conditions, location in vessels, operational patterns and transient conditions. These will generally be defined by the vessels owner or operator.

Further guidance may be found in Annex A, based on IEC 60721-3-6.

4.6.2 Mandatory condition limits

Certain environmental condition parameters and associated severity values are specified by appropriate authorities and represent limits, consequently constituting a basis for design. The requirements generally applicable are given in Tables 1 to 5.

Table 1 – Condition limits

Angular deviation and motion		
Static condition	Angular deviation about for-and-aft axis (list)	
	General conditions	± 15°
	Emergency conditions [a]	± 22° 30'
	Angular deviation about athwartship axis (trim)	
	Emergency conditions [a]	± 10°
Dynamic condition	Rotation about fore-and-aft axis (rolling) [b]	± 22° 30'
	Rotation about athwartship axis (pitching) [b]	± 7° 30'
Low air temperature		
Emergency generator sets		Min. 0 °C
[a] The vessel in any combination of angles within these limits.		
[b] These motions may occur simultaneously.		

4.6.3 Design parameters

4.6.3.1 General

Design parameters based on environmental conditions applicable to certain types of equipment have been established in other parts of the IEC 60092 series, and are described in 4.6.3.2 to 4.6.3.5.

4.6.3.2 Temperature

In other parts of the IEC 60092 series, where no "high air temperature" has been specified as a design parameter for equipment, an average value over a 24 h period of 40 °C with a maximum value of 45 °C shall apply.

Where equipment is designed to operate with temperatures higher or lower than those stated, permissible temperature rises may be reduced or increased accordingly. All stated unit values are to be considered as the average ambient temperature over a 24 h period and a maximum value is to be defined.

In other parts of the IEC 60092 series, where no "low air temperature" has been specified as a design parameter for equipment, a minimum temperature of 5 °C in general and –25 °C for open decks shall be applied.

4.6.3.3 Humidity

The design parameters for relative humidity are 95 % at 45 °C ambient temperature, unless otherwise specified in other parts of the 60092 series.

NOTE Note the additional damp heat test in IEC 60092-504.

4.6.3.4 Angular deviation and motion

The design parameters for angular deviation and motion are given in Table 2.

Table 2 – Design parameters – Angular deviation and motion

Parameters	Unit value		Type of equipment
Standard			
Static condition – all directions	Angle		
IEC 60092-305:1980	40°		Accumulators (storage batteries)
IEC 60092-504	22,5°		Control and instrumentation
Dynamic condition– all directions	Angle	Frequency Hz	
IEC 60092-504	22,5°	0,1	Control and instrumentation

NOTE IEC 60092-305 applies to accumulator batteries in general. However, it does not address other types than lead-acid and nickel-alkaline. Other battery technologies are under consideration.

4.6.3.5 Vibration

The design parameters for vibration are given in Table 3.

Table 3 – Design parameters – Vibration

Parameters		Unit value			Type of equipment
Standard	**Table**				
Vibration		Displacement[a] mm	Acceleration[a] g	Frequency Hz	
IEC 60092-504:2016	Table 1, 10	1,0		2-13,2	Control and instrumentation
			0,7	13,2-100	
IEC 60092-504:2016	Table 1,10	1,6		2-25	Control and instrumentation, special location
			4	25-100	
[a] Amplitude values.					

4.7 Materials

In general, all electrical equipment shall be constructed of durable, flame-retardant material, which is not detrimentally affected due to moisture, the atmosphere and the temperatures to which they are likely to be exposed.

The flame-retardant material shall comply with the needle flame test of IEC 60695-11-5 according to the following specifications.

The flame shall be applied:

– 5 times for 15 s each time. The interval between each application shall be 15 s, or

– 1 time for 30 s;

The layer surrounding or situated below the test specimen shall be of wrapped tissue paper. The dripping height shall be 200 mm ± 5 mm.

Additional acceptance criteria to those specified in IEC 60695-11-5: the burnt out or damaged part of the specimen shall not be more than 60 mm long.

NOTE 1 The additional test specifications and test criteria are given to align with IACS requirements.

NOTE 2 For further information regarding environmental conditions, refer to IEC 60721-3-6.

4.8 Power supply system characteristics

4.8.1 General

Unless otherwise stated in other parts of the IEC 60092 series, equipment shall function when supplied from general distribution systems with due regard to voltage and frequency variations, harmonic distortion and conducted disturbances, measured at the terminals of the equipment. The characteristics of general distribution systems are given in 4.8.2 and 4.8.3.

For systems where semiconductors are connected having a total system rating which is a significant portion of the total system rating, it may not be feasible to suppress the harmonics. Consideration should be given to take appropriate measures to attenuate these effects of the distribution system so that safe operation is assured. Care should be taken in selecting consumers supplied from an electric power supply system with a higher harmonic content than specified in this clause and it should be ensured that the equipment is appropriate for the harmonic content that will be encountered.

Electrical equipment which requires a higher quality power supply may need additional provisions to be made locally. Where additional equipment is fitted to achieve this higher quality power supply it may be required to be duplicated and segregated to the same degree as the electrical equipment it supplies.

Special attention should be paid to the installation of electrical equipment which may influence the quality of power supply on local basis or react with any harmonics present on the general distribution system.

Variable frequency/voltage systems may be admissible provided safe operation of the system is assured and that equipment is suitably rated for the expected variations.

4.8.2 AC distribution systems

4.8.2.1 Voltage characteristics

Tolerances are expressed in a percentage of the nominal voltage.

Voltage are root mean square (RMS) unless otherwise stated.

Voltage tolerance (continuous) ..... +6 % –10 %

Voltage unbalance tolerance including phase voltage unbalance as a result of unbalance of load according to IEC 60092-201 ..... 7 %

Phase to phase voltage unbalance (continuous) ..... 3 %

Cyclic voltage variation (continuous) ..... 2 %

Voltage transients:

– transients (slow) e.g. due to load variations tolerance (deviation from nominal voltage) ..... +20 % –20 %

– voltage transients recovery time ..... maximum 1,5 s

The sum of voltage excursions at any point on the system (tolerances and transient) from nominal voltage should not exceed 20 %.

– fast transients and surges e.g. spikes caused by switching shall not exceed the levels given in IEC 61439-1:2011, Table G.1, and the levels specified in IEC 60533 for AC power ports
– Overvoltage category III

For voltage values, see IEC 61439-1:2011, Table G.1.

NOTE Values for AC systems with rated voltage above 1 000 V are not given in IEC 61439-1.

For voltage harmonic distortion, acceptance limits shall correspond to IEC 61000-2-4, Class 2. In addition, no single harmonic shall exceed 5 % and the THD shall not exceed 8 %.

Other values may be considered subject to approval of the appropriate authority.

Some equipment may require IEC 61000-2-4, Class 1, i.e. no single harmonic shall exceed 3 % and the THD shall not exceed 5 %.

4.8.2.2 Frequency characteristics

Tolerances are expressed in a percentage of the nominal frequency.

Frequency tolerance (continuous) ..... +5 % –5 %
Frequency cyclic variation tolerance (continuous) ..... 0,5 %
Frequency transients tolerance ..... +10 % –10 %
Frequency transients recovery time ..... maximum 5 s

The sum of frequency excursions at any point on the system (tolerances and transient) from nominal frequency should not exceed 12,5 %.

4.8.3 DC distribution systems

Tolerances are expressed in a percentage of the nominal voltage.

Voltage tolerance (continuous) ..... +30 % –25 %
Voltage cyclic variation deviation ..... 5 %
Voltage ripple (AC RMS over steady DC voltage) ..... 10 %
Overvoltage ,category III

Lower variations may be agreed by owners and builders where the technology permits

DC Converters may permit closer control of voltages.

NOTE 1 For voltage values, See IEC 61439-1:2011, Table G.1.

NOTE 2 Values for DC systems with rated voltage above 1 000 V are not given in IEC 61439-1.

4.9 Electrical equipment for hazardous areas

When an equipment is required to be suitable for use in hazardous areas, it shall comply with the requirements of the IEC 60079 series.

Such equipment shall be constructed and tested in accordance with the requirements of the IEC 60079 series and be certified as fit for purpose for the actual ambient temperature and other environmental conditions, to the satisfaction of the appropriate authority.

NOTE Certification is done by a nationally accredited testing Institution.

Unless otherwise indicated in the IEC 60092 series, all such apparatus may be installed in accordance with the relevant clauses contained in IEC 60079-14.

4.10 Precautions necessary when electrical fittings, cables, etc., are attached to structures of conductive materials with different galvanic potential

4.10.1 If electrical fittings, not of aluminium, are attached to aluminium, suitable means shall be taken to prevent galvanic corrosion.

4.10.2 During both the selection and installation of electrical equipment special considerations shall be given to avoid galvanic corrosion.

4.11 Clearance and creepage distances

The distances between live parts of different potential and between live parts and the cases of other earthed metal, whether across surfaces or in air, shall be adequate for the working voltage, having regard to the nature of the insulating material and the conditions of service. Unless otherwise specified a pollution degree 3 according to IEC 60664-1 shall be assumed.

4.12 Insulation

Insulating materials and insulated windings shall be resistant to moisture, sea air and oil vapour, unless special precautions are taken to protect insulants against such agents. Insulating materials in direct contact with conductors, such as busbar supports, should have sufficient resistance against tracking. It is recommended that the comparative tracking index of such materials be not less than 175 V when determined according to IEC 60112.

4.13 Maintenance and inspection

Equipment shall be so designed and installed as to permit its being maintained and inspected in accordance with the manufacturer's recommendations.

4.14 Degrees of protection of enclosures

Enclosures referred to in the various parts of the IEC 60092 series are those as defined in IEC 60529 and shall have the appropriate degree of protection for their designated location on the vessel as specified in the relevant part of the IEC 60092 series. The designation to indicate the degrees of protection consists of the characteristic letters IP followed by two numerals (the "characteristic numerals") indicating conformity with the conditions stated in IEC 60529.

4.15 Cable entries

Cable glands or bushings, or fittings for screwed conduits, shall be suitable for the intended cables and shall facilitate the cable entrance into the equipment. All entries shall maintain the degree of protection provided by the enclosure of the associated equipment.

4.16 Precautions against vibration and mechanical shock

Machines and apparatus shall be unaffected by vibration and shock likely to arise under normal service. Connections shall be secured against becoming loose due to vibration.

4.17 Position in ship

4.17.1 Electrical equipment is to be located in compartments which are suitably constructed and, if necessary, ventilated.

4.17.2 Electrical equipment shall not be installed where flammable gases or vapours are liable to accumulate unless necessary for operational purposes. Any electrical equipment so located is to be in accordance with the relevant requirements of this standard for such a location.

4.18 Mechanical protection

Electrical equipment shall be placed so that, as far as practicable, it is not exposed to risk of mechanical damage.

4.19 Protection from water, steam and oil

Electrical equipment shall be so selected and located or protected from the effects of exposure to saliferous atmosphere, water, steam, oil or oil fumes, spray, ice formation, etc., that the effects are minimised. It should be located well clear of boilers, steam, oil or water pipes, and engine exhaust pipes and manifolds, unless specifically designed for such locations. If pipes must be run adjacent to electrical equipment, there shall be no flanges in the immediate vicinity of the electrical equipment.

Where electrical equipment is located such that there is a danger of dripping or spraying water, it shall have an appropriate IP rating.

Where sprinkler heads or water spraying devices are fitted for fire-fighting, due consideration should be given to the siting of electrical equipment which would be seriously affected by the inadvertent operation of the extinguishing arrangement. This is particularly applicable to switchgear and switch rooms, where a suitable alternative method of extinguishing should be used.

4.20 Protection against electrical shock

4.20.1 All electrical equipment shall be constructed or located in such a way that live parts cannot be inadvertently touched during normal operation including opening of panel doors for the resetting of relays, unless they are supplied by extra low voltage according to IEC 61140.

NOTE Requirements related to the operation of electrical systems are given in IEC 60092-509.

4.20.2 Equipment supplied at nominal voltages in excess of 500 V and accessible to non-authorized persons shall have a degree of protection against touching live parts of at least IP4X according to IEC 60529.

4.20.3 Exposed metal parts of electrical machines or equipment which are not intended to be live but which are liable under fault conditions to become live shall be earthed unless the machines or equipment are:

– supplied at a voltage not exceeding 50 V direct current or 50 V, root mean square between conductors; auto-transformers shall not be used for the purpose of achieving this voltage; or
– supplied at a voltage not exceeding 250 V by safety isolating transformers supplying only one consuming device; or
– constructed in accordance with the principle of double insulation.

4.21 Axes of rotation

Every horizontal rotating machine should be installed preferably with the shaft in the fore-and-aft direction. Where a machine is installed athwartship, it shall be ensured that the design of

the bearings and the arrangements for lubrication are satisfactory to withstand the rolling specified in 4.6.2. The manufacturer shall be informed when a machine for installation athwartship is ordered.

4.22 Magnetic compasses

Conductors and equipment shall be placed at such a distance from the compass, or shall be so screened, that the interfering external magnetic field is negligible (deviation less than 0,5°, i.e. 30’ (minutes)), even when circuits are switched on and off.

4.23 Environmental impact

The design, construction and maintenance shall, wherever possible, consider:

a) the impact on the environment;

b) the efficient use of generated power;

c) the actual environmental values, e.g. temperature variations, over the year and operational area;

d) the use of high efficiency (IE2) or premium efficiency (IE3) motors in accordance with IEC 60034-30-1;

e) the re-use of waste energy in HVAC installations;

f) the use of low energy luminaires and efficient switching arrangements.

Consideration should be given to establishing an energy management system.

Energy optimization by use of i.e. brake energy or waste heat recovery should be evaluated.

NOTE The applicability of IMO Resolution MEPC.212(63) requirement for the Energy Efficiency Design Index (EEDI) to the vessel is determined by the Flag Administration.

Annex A
(informative)

Guidance on environmental conditions

This annex is a non-mandatory guide giving details of the environmental conditions for electrical installations of ships and of mobile and fixed offshore units.

The guidance is presented in five tables, A.1 to A.5. Table A.1 contains a survey of environmental conditions related to specific locations and is intended to serve as the introduction to the remaining tables. Tables A.2 to A.5 deal with specific conditions, i.e. climatic, biological, mechanical and those dependent on chemically and mechanically active substances.

The parameters of environmental conditions and their severities given in Tables A.2 to A.5 are based on IEC 60721-3-6.

The severities given are those which will have a low probability of being exceeded. Only severe conditions which affect the structural integrity or functional performance are included. Accidental incidents are not included, but the possibility of their occurrence may need to be taken into account for products vital to the safety of the vessel. In the tables, the expression "General" refers to the least severe conditions.

The simultaneous occurrence of environmental parameters is envisaged in the guidance, but is not always a reality. Furthermore, no reference to duration of parameters or severities, or to frequency of operation in certain climates or areas, has been made.

In Tables A.2 to A.5, the first column describes the locations and, where applicable, the areas or conditions of operation.

The last column indicates, for each item in the first column, the designation of the class according to IEC 60721-3-6, which is the lowest class covering the environmental conditions specified. In the majority of cases this class covers more parameters or higher severities than those listed. The use of the class is optional.

In the remaining columns of Tables A.2 to A.5, an X indicates the applicable environmental parameter and its severity.

In Table A.2, an O indicates the type of open-air climate in which the vessel is navigated.

The types of open-air climate covered are, according to IEC 60721-2-1, the following:

C = Cold	MWDr = Mild Warm Dry
CT = Cold Temperate	WDa = Warm Damp
WT = Warm Temperate	WdaE = Warm Damp Equable
WDr = Warm Dry	

NOTE 1 The open-air types of climate, Warm Damp and Warm Damp Equable, correspond to what is generally termed Tropical Belt.

NOTE 2 The most extreme types of open-air climate in IEC 60721-2-1, Extremely Cold and Extremely Warm Dry, can normally only be found in inland areas, and have therefore been excluded here. It is noted, however, that vessels can be subject to these types of climate during inland navigation (on rivers, lakes, etc.) although this is regarded as very exceptional.

Table A.1 – Survey of environmental conditions related to locations

Conditions [a]		Climatic		Biological		Chemically active substances		Mechanically active substances		Mechanical	
Locations [b]		Item of Table A.2 [b]	Class [c]	Item of Table A.3 [b]	Class [c]	Item of Table A.4 [b]	Class [c]	Item of Table A.4 [b]	Class [c]	Item of Table A.5 [b]	Class [c]
1	Navigation bridge (wheelhouse, wireless-room, chartroom)	1.2 + 1.4	6K2	2 + 3	6B2	1.1	6C1	1.1	6S1	1.1	6M2
2	Control rooms	1.2	6K2	2 + 3	6B2	1.1	6C1	1.1	6S1	1.1	6M2
3	Accommodation spaces	1.2 +1.4	6K2	2 + 3	6B2	1.1	6C1	1.1	6S1	1.1	6M2
4	Air-conditioned spaces	1.2 + 1.4	6K2	2 + 3	6B2	1.1	6C1	1.1	6S1	1.1	6M2
5	Lavatories, bathrooms, showers	1.2 + 1.5	6K2	2 + 3	6B2	1.1	6C1	1.1	6S1	1.1	6M2
6	Galleys, laundries, pantries	1.2 + 1.5 +1.6	6K3	2 + 3	6B2	1.1	6C1	1.1	6S1	1.1	6M2
7	General stores, provision rooms	1.2	6K2	2 + 3	6B2	1.1	6C1	1.1	6S2	1.1	6M2
8	Machinery spaces	1.7.2	6K3	2 + 3	6B2	1.4.1	6C1	1.4.1	6S1	1.1	6M2
9	Refrigerated cargo spaces	1.2 + 1.8	6K5	2 + 3	6B2	1.1	6C1	1.1	6S1	1.1	6M2
10	Steering gear rooms	1.7.2	6K3	2 + 3	6B2	1.1	6C1	1.1	6S1	1.4	6M3
11	General cargo spaces	2.2 + 2.3 +2.6	6K5	2 + 3	6B2	1.2	6C2	1.3	6S2	1.1	6M2
12	Semi-enclosed spaces	3.2 + 3.3 +3.5	6K5	2 + 3	6B2	1.2	6C2	2.2.3	6S3	1.1	6M2
13	Open decks	3.2 + 3.3 +3.6	6K5	2 + 3	6B2	2.2.1	6C3	2.2.3	6S3	1.1	6M2
14	External submerged parts of hull	4.3	6K2	2 + 3	6B2	2.2.1	6C3	2.2.1	6S1	1.1	6M2

[a] Conditions include those related to all types of open-air climates, to all geographical areas with biological risk, and to vessels in excess of approximately 500 t gross tonnage, but not passing through ice.

[b] When locations and conditions not referred to in Table A.1 are applicable, consideration should be given to the appropriate items of Tables A.2 to A.5.

[c] Lowest environmental class needed according to IEC 60721-3-6.

Table A.2 – Environmental condition guidance – Climatic conditions

Climatic conditions according to IEC 60721-3-6	Type of open air climate 1)			Temperature													Humidity 7)			Combined with rapid change of temperature air/air at high		Low	Move-ment of sur-rounding air	Preci-pitation	Radiation				Water from sources other than rain			Wet-ness	Lowest environ-mental class needed according to IEC 60721-3-6
				Low				Surface						Change of temperature			High relative not combined with rapid change of temperature								Solar		Heat						
				air 2)		water 3)		air 4)		surface 5)		water		gradual air/air 2) 6)		air / water				relative humidity 6)	water content 8)	relative %	Rain 7) 9)		10)				11)				
				°C				°C		°C		°C		°C min		°C	%			°C	g/m³	°C	m/s	mm/min	W/m²		W/m²		m/s				
Locations	C	CT WT WDr MWDr	Wda WdaE	+5	-25	-40	free-zing point	40	55	70	70	25	30	35	-25/+20 1	-25/+40 3	40/5	95 30	95 35	95 45	95 -25/+35	95 +70/+15	10 30	30	50	6	15	700	1 120	600	1 200	0,3	3	10	Conditions of wet surfaces	
1 *Locations, totally weatherprotected, heated, ventilated* 12)																																		
1.1 General	O	O		X				X									X					X												6K1
1.2 Operation in types of open-air climates Warm Damp and Warm Damp Equable	O	O	O	X				X										X				X												6K2
1.3 In proximity to heaters	O	O		X				X									X					X							X					6K2
1.4 Subject to solar radiation through glass	O	O		X				X									X					X					X							6K2
1.5 Subject to dripping water	O	O		X				X									X					X									X			6K2
1.6 Containing equipment dissipating considerable heat	O	O		X					X								X					X												6K3
1.7 Machinery spaces																																		
1 General	O	O		X				X									X					X									X			6K2
2 Operation in types of open-air climates. Warm Damp and Warm Damp Equable	O	O	O	X					X									X				X									X			6K3
3 In proximity to equipment radiating moderate heat	O	O		X				X									X					X							X		X			6K2
4 In proximity to equipment radiating considerable heat	O	O		X				X									X					X								X	X			6K3
5 On hot parts of machinery 13)	O	O		X		X		X		X							X					X									X			6K4
1.8 Refrigerated cargo spaces	O	O						X									X					X									X			6K5
1.9 Before and during warm-up 14)																																		

Climatic conditions according to IEC 60721-3-6	Type of open air climate 1)			Temperature													Humidity 7) High relative not combined with rapid change of temperature			Combined with rapid change of temperature air/air at high		Low relative	Movement of surrounding air rain	Precipitation Rain 7) 9)		Radiation Solar 10)		Heat 10)		Water from sources other than rain 11)			Wetness	Lowest environmental class needed according to IEC 60721-3-6
				Low				Surface						Change of temperature																						
				air 2)			water 3)	air 4)			surface 5)	water			gradual air/air 2) 6)		air / water				relative humidity 6)	water content 8)													
				°C				°C			°C	°C			°C min		°C	°C			%	g/m³	°C	m/s	mm/min		W/m²		W/m²		m/s				
Locations	C	CT WT WDr MWDr	Wda WdaE	+5	-25	-40	free-zing point	40	55	70	70	25	30	35	-25/+20 1	-25/+40 3	40/5	95 30	95 35	95 45	95 -25/+35	95 +70/+15	10 30	30	50	6	15	700	1 120	600	1 200	0,3	3	10	Conditions of wet surfaces	
1 General		O			X			X							X			X					X												6K2
2 In type of open-air climate Cold	O	O				X		X							X			X					X												6K5
3 Machinery spaces		O		X				X								X		X					X												6K3
1.10 During loading and unloading [14)]																																				
1 Close to gates, ramps, covers	O	O				X		X								X			X				X												6K3
2 Refrigerated cargo spaces	O	O				X		X								X			X		X		X												6K5
2 *Locations, totally weatherprotected, unheated*																																				
2.1 General		O			X			X								X							X												6K2
2.2 Operation in types of open-air climates Warm Damp and Warm Damp Equable		O	O		X			X										X					X												6K2
2.3 Operation in type of open-air climate Cold [15)]		O	O			X		X											X				X				X								6K5
2.4 Ventilated, subject to solar radiation through glass		O			X			X										X					X												6K2
2.5 Ventilated wet areas, e.g. on wet surfaces		O			X			X										X					X										X		6K3
2.6 Subject to dripping water		O			X			X										X					X								X				6K2

Climatic conditions according to IEC 60721-3-6	Type of open air climate 1)			Temperature													Humidity 7)			Combined with rapid change of temperature air/air at high		Low	Movement of surrounding air rain		Precipitation Rain 7) 9)		Radiation Solar		Heat 10)		Water from sources other than rain 11)			Wetness	Lowest environmental class needed according to IEC 60721-3-6
				Low				Surface						Change of temperature																						
				air 2)		water 3)		air 4)		surface 5)		water			gradual air/air 2) 6) °C	air / water	High relative not combined with rapid change of temperature %			relative humidity 6) %	water content 8) g/m³	relative %													
				°C				°C		°C		°C			°C min	°C	°C			°C	°C	°C	m/s		mm/min		W/m²		W/m²		m/s				
Locations	C	CT WT WDr MWDr	Wda WdaE	+5	-25	-40	freezing point	40	55	70	70	25	30	35	-25/+20 1	-25/+40 3	40/5	95 30	95 35	95 45	95 -25/+35	95 +70/+15	10 30	30	50	6	15	700	1 120	600	1 200	0,3	3	10	Conditions of wet surfaces	
2.7 Unventilated enclosed spaces, the external surface of the enclosure subject to solar radiation																																			
1 Without internal wet surfaces		O			X					X							X					X						X						6K4
2 With internal wet surfaces (evaporation of water)		O			X					X									X			X						X					X	6K4
3 With internal wet surfaces, the external surface subjected to rain or water jets after period of solar radiation		O			X					X									X		X	X						X					X	6K4
3 Locations, not totally weatherprotected																																			
3.1 General		O			X			X									X					X	X		X			X						6K4
3.2 Operation in types of open-air climates Warm Damp and Warm Damp Equable		O	O		X			X									X					X	X		X			X						6K4
3.3 Operation in type of open-air climate Cold[15)]	O	O				X		X									X					X	X		X			X						6K5
3.4 Operation in areas with abnormal rain intensities and hurricanes		O			X			X									X					X		X		X		X						6K5
3.5 Subject to water jets		O			X			X									X					X	X		X			X				X		6K4
3.6 Subject to heavy seas		O			X			X									X					X	X		X			X					X	6K5
4 *Locations, submerged*																																			
4.1 General	O	O					X					X																							6K1
4.2 Operation in types of open-air climates Warm Damp and Warm Damp Equable	O	O	O				X						X																					6K1
4.3 Operation in areas with high water temperature, for example the Arabian Gulf	O	O					X							X																				6K2

[1] Type of open-air climate in which the vessel is navigated (according to IEC 60721-2-1)

C: Cold
CT: Cold Temperate
WT: Warm Temperate
WDr: Warm dry
MWDr: Mild Warm dry
WDa: Warm Damp
WDaE: Warm Damp Equable

[2] A number of products in machinery spaces are required to operate only after a period of warming-up. For these products, the low temperature for operation is +5 °C, and the Gradual Change of Temperature condition applies only to the non-operational state.

[3] The freezing-point may be below 0 °C due to the presence of salt or other substances.

[4] For control and instrumentation equipment located in panels or cubicles, consideration should be given to the temperature rises inside those panels or cubicles due to the dissipation of heat from components therein.

[5] Surface temperature refers to hot parts to which a product may be attached. More extreme surface temperature can exist, and may have to be considered.

[6] The change of temperature is either an increase or a decrease.

[7] It should be noted that formation of ice may occur in locations on externally or internally mounted products, possibly causing malfunction of moving parts. This can be caused by condensation and freezing on cold surfaces, undercooled rain water, or the combination of air velocity and relative humidity (depending on product shape).

[8] The rapid change of temperature is a rapid decrease. The figure of water content applies to temperatures down to dew-point. At lower temperatures, relative humidity is assumed to be 100 %.

[9] Drop sizes may also be of importance, especially combined with high wind speeds.

[10] The lower value applies to glass not specifically treated to reduce heat transmission.

[11] The velocity should not be taken as the amount of water collected on a surface per time unit.

[12] Failure of the ventilation, heating or air-conditioning system may change the environmental condition specified.

[13] For boilers, engines, etc., more extreme temperatures may exist, depending on type of boiler or engine, and exact location. Such cases are not covered here and have to be specially considered.

[14] Transient conditions.

[15] Vessels will not normally be navigated in air temperatures below –40 °C. Temperatures may fall below –40 °C, however, when vessels are laid up and left unprotected. In such cases the temperature may reach –55 °C.