INTERNATIONAL STANDARD

IEC 61892-3

First edition
1999-02

Mobile and fixed offshore units – Electrical installations –

Part 3: Equipment

Unités mobiles et fixes en mer – Installations électriques –

Partie 3: Matériel

Reference number
IEC 61892-3:1999(E)

Numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series.

Consolidated publications

Consolidated versions of some IEC publications including amendments are available. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Validity of this publication

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology.

Information relating to the date of the reconfirmation of the publication is available in the IEC catalogue.

Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is to be found at the following IEC sources:

- **IEC web site***
- **Catalogue of IEC publications**
  Published yearly with regular updates
  (On-line catalogue)*
- **IEC Bulletin**
  Available both at the IEC web site* and as a printed periodical

Terminology, graphical and letter symbols

For general terminology, readers are referred to IEC 60050: *International Electrotechnical Vocabulary* (IEV).

For graphical symbols, and letter symbols and signs approved by the IEC for general use, readers are referred to publications IEC 60027: *Letter symbols to be used in electrical technology*, IEC 60417: *Graphical symbols for use on equipment. Index, survey and compilation of the single sheets* and IEC 60617: *Graphical symbols for diagrams*.

* See web site address on title page.

INTERNATIONAL STANDARD

IEC 61892-3

First edition
1999-02

Mobile and fixed offshore units – Electrical installations –

Part 3: Equipment

Unités mobiles et fixes en mer – Installations électriques –

Partie 3: Matériel

International Electrotechnical Commission 3, rue de Varembé Geneva, Switzerland
Telefax: +41 22 919 0300 e-mail: inmail@iec.ch IEC web site http://www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE XB

For price, see current catalogue

CONTENTS

Page

FOREWORD 5
INTRODUCTION 6

Clause

1 Scope 7
2 Normative references 7
3 Definitions 9
4 Generators and motors 12
4.1 General 13
4.2 Performance characteristics 13
4.3 Voltage regulation of generators 13
4.4 Generators for special purposes 15
4.5 Parallel operation of general service generators – DC generators 15
4.6 Parallel operation of general service generators – AC generators 15
4.7 Control and excitation of generators 16
4.8 Mechanical features (generators and motors) 17
4.9 Lubrication (generators and motors) 18
4.10 Prime movers 18
4.11 Cyclic irregularity 19
4.12 Lubrication (prime movers) 19
4.13 Running speed 20
4.14 Testing 20
4.15 Degree of protection provided by enclosures 20
4.16 Rating plates 20
5 Transformers for power and lighting 24
5.1 General 24
5.2 Winding arrangement 24
5.3 Terminals 24
5.4 Cooling arrangements 24
5.5 Voltage regulation 25
5.6 Parallel operation 25
5.7 Temperature-rise limits 25
5.8 Tests 25
6 Switchgear and controlgear assemblies 25
6.1 General 25
6.2 Definitions 25
6.3 Classification of assemblies 25
6.4 Electrical characteristics of assemblies 25
6.5 Information to be given regarding the assemblies 25
6.6 Environmental conditions 27
6.7 Design and construction 27
6.8 Test specifications 34
6.9 Switchgear and controlgear in the range above 1 kV up to and including 15 kV 36

Clause Page

7 Semiconductor convertors 39
7.1 General 39
7.2 Cooling arrangements 39
7.3 Accessibility 39
7.4 Service conditions 39
7.5 Application 39
7.6 Nameplate 40
7.7 Convertor transformers 40
8 Secondary cells and batteries 40
8.1 General 40
8.2 Types of battery 40
8.3 Construction and assembly 40
8.4 Crates and trays 41
8.5 Location 41
8.6 Nameplates 41
8.7 Charging facilities 41
8.8 Ventilation of secondary battery compartments 42
9 Luminaires 42
9.1 General 42
9.2 Construction 42
9.3 Temperature and temperature rise 43
9.4 Standard types of lampholders 43
9.5 Exposure to mechanical damage 44
9.6 Discharge lamp luminaires operating at voltages below 250 V 44
9.7 Discharge lamp luminaires operating at voltages above 250 V 44
9.8 Searchlights and arc lamps 45
9.9 Portable luminaires 45
9.10 Marking 45
10 Heating and cooking appliances 45
10.1 General 45
10.2 General requirements 45
10.3 Special requirements for galley appliances 48
10.4 Special requirements for space-heating appliances 48
11 Trace and surface heating 49
11.1 General 49
11.2 Construction 49
11.3 Protection 49
11.4 Protection against mechanical damage 49
11.5 Installation in hazardous areas 49
12 Communication 49
12.1 General 49
12.2 Safety requirements 50
12.3 Other requirements 50
12.4 Safety and maintenance 50

Clause Page

13 Underwater systems and appliances 50
13.1 General 50
13.2 Fixed diving systems 50
13.3 Temporary diving systems 50
14 Control and instrumentation 51
14.1 General 51
14.2 General requirements 51
14.3 Environmental and supply conditions and testing 51
14.4 Adjustments 57
14.5 Accessibility 57
14.6 Replacement 57
14.7 Non-interchangeability 57
14.8 Cooling air 57
14.9 Mechanical load on connectors 57
14.10 Mechanical features of cabinets 57
14.11 Shock and vibration absorbers 57
14.12 Internal wiring 57
14.13 Cable connections 58
14.14 Rodent protection 58
14.15 Sensors 58
14.16 Computer-based systems 58
15 Accessories 61
15.1 General 62
15.2 Enclosures 62
15.3 Switches 62
15.4 Socket outlets and plugs 62

Annex A (informative) Bibliography 64

Table 1 – Limits of cyclic irregularity 19
Table 2 – Limits of temperature rise of air-cooled machines based on an ambient temperature of 50 °C 21
Table 3 – Dielectric tests 23
Table 4 – Clearance and creepage distances for non type-tested assemblies 29
Table 5 – Correspondence between the nominal voltage of the supply system and the test voltage for type-tested assemblies at sea level 38
Table 6 – Standard types of lampholders 43
Table 7 – Temperature limits of exposed parts 47
Table 8 – Variations from nominal values 53
Table 9 – Type tests, test procedures and severities 54

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

MOBILE AND FIXED OFFSHORE UNITS – ELECTRICAL INSTALLATIONS –

Part 3: Equipment

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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 the 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 National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61892-3 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

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

FDIS	Report on voting
18/859/FDIS	18/864/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.

Annex A is for information only.

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

IEC 61892 consists of the following parts, under the general title *Mobile and fixed offshore units – Electrical installations*

Part 1: *General requirements and conditions*
Part 2: *System design*
Part 3: *Equipment*
Part 4: *Cables*
Part 5*: Mobile units*
Part 6: *Installation*
Part 7: *Hazardous areas*

INTRODUCTION

IEC 61892-3 forms part of a series of International Standards intended to ensure safety in the design, selection, installation, maintenance and use of electrical equipment for the generation, storage, distribution and utilization of electrical energy for all purposes in offshore units which are used for the purpose of exploration or exploitation of petroleum resources.

This standard also incorporates and co-ordinates, as far as possible, existing rules and forms a code of interpretation, where applicable, of the requirements of the International Maritime Organization, and constitutes a guide for future regulations which may be prepared and a statement of practice for offshore unit owners, constructors and appropriate organizations.

This standard is based on equipment and practices which are in current use, but it is not intended in any way to hamper development of new or improved techniques.

The ultimate aim has been to produce a set of International Standards exclusively for the offshore petroleum industry.

In this part of IEC 61892, references are made to other parts of the standard, which are still in preparation. Footnotes are attached to such references. A footnote indicates which current standard should be used until the part in preparation is published.

MOBILE AND FIXED OFFSHORE UNITS – ELECTRICAL INSTALLATIONS –

Part 3: Equipment

1 Scope

This part of IEC 61892 contains provisions for electrical equipment in electrical installations of mobile and fixed units, including pipelines, pumping or "pigging" stations, compressor stations and exposed location single-buoy moorings, used in the offshore petroleum industry for drilling, production, processing and for storage purposes.

It applies to equipment in all installations, whether permanent, temporary, transportable or hand-held, to a.c. installations up to and including 15 000 V and d.c. installations up to and including 1 000 V.

This standard does not apply to the electrical installations in rooms used for medical purposes or in tankers.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61892. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 61892 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60034-1:1996, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60044-1:1996, *Instrument transformers – Part 1: Current transformers*

IEC 60050(441):1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*

IEC 60056:1987, *High-voltage alternating-current circuit-breakers*

IEC 60065:1998, *Audio, video and similar electronic apparatus – Safety requirements*

IEC 60076-1:1993, *Power transformers – Part 1: General*

IEC 60076-2:1993, *Power transformers – Part 2: Temperature rise*

IEC 60076-3:1980, *Power transformers – Part 3: Insulation levels and dielectric tests*

IEC 60076-3-1:1987, *Power transformers – Part 3: Insulation levels and dielectric tests – Section 1: External clearances in air*

IEC 60076-5:1976, *Power transformers – Part 5: Ability to withstand short-circuit*

IEC 60092-101:1994, *Electrical installations in ships – Part 101: Definitions and general requirements*

IEC 60092-201:1994, *Electrical installations in ships – Part 201: System design – General*

IEC 60092-401:1980, *Electrical installations in ships – Part 401: Installation and test of completed installation*

IEC 60092-504:1994, *Electrical installations in ships – Part 504: Special features – Control and instrumentation*

IEC 60092-505:1984, *Electrical installations in ships – Part 505: Special features – Mobile offshore drilling units*

IEC 60146-1-1:1991, *Semiconductor convertors – General requirements and line commutated convertors – Part 1-1: Specifications of basic requirements*

IEC 60146-1-2:1991, *Semiconductor convertors – General requirements and line commutated convertors – Part 1-2: Application guide*

IEC 60146-1-3:1991, *Semiconductor convertors – General requirements and line commutated convertors – Part 1-3: Transformers and reactors*

IEC 60146-2:1974, *Semiconductor convertors – Part 2: Semiconductor self-commutated convertors*

IEC 60146-3:1977, *Semiconductor convertors – Part 3: Semiconductor direct d.c. convertors (d.c. chopper convertors)*

IEC 60265-1:1998, *High-voltage switches – Part 1: High-voltage switches for rated voltages above 1 kV and less than 52 kV*

IEC 60282 (all parts), *High-voltage fuses*

IEC 60298:1990, *AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

IEC 60309 (all parts), *Plugs, socket-outlets and couplers for industrial purposes*

IEC 60364-4-41:1992, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 41: Protection against electric shock*

IEC 60439-1:1992, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies*

IEC 60466:1987, *AC insulation-enclosed switchgear and controlgear for rated voltage above 1 kV and up to and including 38 kV*

IEC 60519 (all parts), *Safety in electroheat installations*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60533:1977, *Electromagnetic compatibility of electrical and electronic installations in ships*

IEC 60617 (all parts), *Graphical symbols for diagrams*

IEC 60669 (all parts), *Switches for household and similar fixed-electrical installations*

IEC 60865-1:1993, *Short-circuit currents – Calculation of effects – Part 1: Definitions and calculation methods*

IEC 60884 (all parts), *Plugs and socket-outlets for household and similar purposes*

IEC 60906 (all parts), *IEC system of plugs and socket-outlets for household and similar purposes*

IEC 61131 (all parts), *Programmable controllers*

IEC 61131-1:1992, *Programmable controllers – Part 1: General information*

IEC 61131-2:1992, *Programmable controllers – Part 2: Equipment requirements and tests*

IEC 61346-1:1996, *Industrial systems, installations and equipment, and industrial products – Structuring principles and reference designations – Part 1: Basic rules*

IEC 61363-1:1998, *Electrical installations of ships and mobile and fixed offshore units – Part 1: Procedures for calculating short-circuit currents in three-phase a.c.*

IEC 61892-6:1999, *Mobile and fixed offshore units – Electrical installations – Part 6: Installation*

IEC 61892-7:1997, *Mobile and fixed offshore units – Electrical installations – Part 7: Hazardous areas*

ISO 6592:1985, *Information processing – Guidelines for the documentation of computer-based application systems*

ISO 8528-5:1993, *Reciprocating internal combustion engine driven alternating current generating sets – Part 5: Generating sets*

3 Definitions

For the purpose of this part of IEC 61892, the following definitions apply.

3.1
computer-based system
system that consists of one or more programmable electronic devices with the connections, peripherals and software necessary to automatically carry out specified functions

NOTE – The following types of programmable devices could form part of a computer system: mainframe, mini-computer, micro-computer, programmable logic controller.

3.2
convertor
a set of equipment, static or rotating, to convert one type of electric current to another type, different in nature, voltage and/or frequency

3.3
distribution board
switchgear or controlgear assembly for the control and distribution of electrical power to final subcircuits

3.4
double insulation
insulation comprising both basic insulation and supplementary insulation

3.5
electric surface heating
heat generated in the surface layer of a body to be heated by electrical means in order to raise or maintain its temperature

3.6
electric surface heating device
resistive or skin effect device designed to produce a defined output at a declared voltage and temperature, and terminated in a manner suitable for connection to the electricity supply

3.7
electric surface heating systems
system of electric surface heating devices together with any controls, thermal insulation and protective cladding designed to meet a specified electric surface heating requirement

3.8
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

3.9
emergency switchboard
switchgear and controlgear assembly which is normally supplied by the main switchboard but which, in the event of failure of the main electrical power supply system, is directly supplied by the emergency source of electrical power or the transitional source of emergency power and is intended to distribute and control electrical energy to the emergency services for all electrical consumers essential to the safety of the crew, contractors, visitors and the unit under emergency conditions

3.10
expert system
intelligent knowledge based system that is designed to solve a problem using information that has been compiled from some form of human expertise

3.11
extra-low voltage (safety voltage)
voltage which does not exceed 50 V a.c. r.m.s. between conductors, or between any conductor and earth, in a circuit isolated from the supply by means such as safety isolating transformers, or convertors with separate windings; a voltage which does not exceed 50 V d.c. between conductors, or between any conductor and earth, in a circuit which is isolated from higher voltage circuits.

NOTE 1 – Consideration should be given to the reduction of the limit of 50 V under certain conditions, such as wet surroundings, exposure to heavy seas or powerful water jets where direct contact with live parts is involved.

NOTE 2 – The voltage limit should not be exceeded, either at full load or no load, but it is assumed, for the purpose of this definition, that any transformer or convertor is operated at its rated supply voltage.

NOTE 3 – Information about protection by extra-low voltage is given in IEC 60364-4-41.

3.12
heating cable
cable, with or without a shield or a metallic sheath, intended to give off heat for heating purposes

3.13
invertor
convertor for conversion from d.c. to a.c

3.14
low-voltage switchgear and controlgear assemblies
combination of one or more low-voltage switching devices together with associated control, measuring, signalling, protective, regulation equipment, etc., completely assembled under the responsibility of the manufacturer with all the internal electrical and mechanical inter-connections and structural parts

3.15
main switchboard
switchgear and controlgear assembly which is directly supplied by the main source of electrical power and is intended to distribute and control electrical energy to the unit's services

3.16
non-type-tested low-voltage switchgear and controlgear assemblies (NTTA)
low-voltage switchgear and controlgear assembly which does not belong to 3.17 or 3.28.

3.17
partially type-tested low-voltage switchgear and controlgear assemblies (PTTA)
low-voltage switchgear and controlgear assembly, containing both type-tested and non-type-tested arrangements provided that the latter are derived (e.g. by calculation) from type-tested arrangements which have complied with the relevant tests

3.18
rectifier
convertor for conversion of a.c. to d.c.

3.19
reinforced insulation
single insulation system applied to live parts, which provides a degree of protection against electric shock equivalent to double insulation under the conditions specified in the relevant IEC standard.

NOTE – The term "insulation system" does not imply that the insulation must be one homogeneous piece. It may comprise several layers which cannot be tested singly as supplementary or basic insulation

3.20
resistive device
electric surface heating device of either the trace heating unit type or the surface heating unit type

3.21
ripple-free
conventionally defined for sinusoidal ripple voltage as a ripple content of not more than 10 % r.m.s.; the maximum peak value does not exceed 140 V for a nominal 120 V ripple-free d.c. system and 70 V for a nominal 60 V ripple-free d.c. system

3.22
(secondary) cell *(Syn.* (rechargeable) cell)
an assembly of electrodes and electrolyte which constitutes the basic unit of a secondary battery

3.23
section boards
switchgear and controlgear assembly for controlling and distributing the supply of electrical power to other section boards, distribution boards or final subcircuits

3.24
self-commutated convertor
convertor in which the commutating voltages are supplied by components within the convertor

NOTE – Included, for example, are converters in which the commutating voltages are built up within the semiconductor devices (as in transistors and in thyristors which can be turned off by the gate) or in which they are supplied outside the semiconductor devices by means of capacitors. Excluded are convertors requiring special characteristics from the load to commutate.

3.25
semiconductor device
device whose essential characteristics are due to the flow of charge carriers within a semiconductor

3.26
skin effect device
electric surface heating device of the skin effect heater type

3.27
software
program, procedures and associated documentation pertaining to the operation of a computer system and including both the application (user) program and the operating system (firmware) program

3.28
type-tested low-voltage switchgear and controlgear assembly (TTA)
low-voltage switchgear and controlgear assembly conforming to an established type or system without deviations likely to significantly influence the performance from the typical assembly verified to be in accordance with this standard

3.29
valve-regulated battery cell
a secondary cell which is closed under normal conditions but which has an arrangement which allows the escape of gas if the internal pressure exceeds a predetermined value. The cell cannot normally receive addition to the electrolyte

3.30
vented (secondary) battery cell (*Syn.* open (secondary) cell)
a secondary cell having a cover provided with an opening through which gaseous products may escape

NOTE – The opening may be fitted with a venting system.

4 Generators and motors

4.1 General

The provisions of this clause are applicable to all rotating machines rated at 750 W or more for use in offshore units. It also applies to excitation machines and includes relevant requirements for prime-mover driving generators. Requirements particular to electrical propulsion machines are given in IEC 61892-5[1)]

All electrical machines shall comply with the relevant requirements of IEC 60034-1 and also with the additional requirements included in this standard.

4.2 Performance characteristics

4.2.1 Temperature rise

The limits of temperature rise shall be in accordance with table 2, which is based on IEC 60034-1.

NOTE – When a rotating machine is connected to a supply system with harmonic distortion, the rating of the machine must allow for the increased heating effect of the harmonic loading.

4.2.2 Unbalance load on three-wire d.c. generators

Unless otherwise specified, all three-wire d.c. generators shall be designed for a current unbalance of 25 %.

4.3 Voltage regulation of generators

4.3.1 General

The inherent voltage regulation of a general service generator shall be designed in relation to the speed regulation and governing of the prime movers as outlined below.

NOTE – "General service" means that supplying motors and other consumers are a part of the normal distribution system of the unit. Consumers such as propulsion motors and other special consumers, for which other governing characteristics can be accepted or are required, are not considered part of the general service.

4.3.2 DC generators

4.3.2.1 Shunt or stabilized shunt-wound generators

Shunt or stabilized shunt-wound generators rated at 50 kW and above shall comply with the following requirements:

a) when the voltage has been set at full load to its rated value, the removal of the load shall not cause a permanent increase of the voltage greater than 15 % of the rated voltage;

b) when the voltage has been set either at full load or at no load, the voltage obtained at any value of the load shall not exceed the no-load voltage.

4.3.2.2 Compound-wound generators

Compound-wound generators rated at 50 kW and above shall be so designed in relation to the governing characteristics of the prime-mover that, with the generator at full-load operating temperature and starting at a 20 % load with voltage within 1 % of the rated voltage, it gives at full load a voltage within 1,5 % of the rated voltage.

---

1) In preparation. Before IEC 61892-5 is published, see IEC 60092-101.

The average of ascending and descending voltage regulation curves between 20 % load and full load shall not vary by more than 3 % from the rated voltage.

4.3.2.3 Other types of generators

Generators required to have characteristics not covered by 4.3.2.1 and 4.3.2.2 shall be subject to special consideration.

4.3.2.4 Automatic voltage regulation for d.c. service generators

General service generators which are of the shunt type shall be provided with automatic voltage regulators.

4.3.3 AC generators

The excitation system of a.c. generators rated 50 kW and above, and complying with 4.7.4, shall also comply with the requirements given below.

4.3.3.1 Steady conditions: tolerance of voltage and waveform

Each a.c. generator for general service driven by its prime-mover, whose governor characteristics comply with 4.10.3, shall be provided with an excitation system capable of maintaining the voltage under steady conditions within ±2,5 % of the rated voltage for all loads between zero and rated load at the rated power factor. These limits may be increased to ±3,5 % for emergency sets (see 4.3.3.4).

When the generator is driven at rated speed, giving its rated voltage and rated symmetrical load, the tolerance of waveform shall not exceed the values listed below:

– total harmonic distortion: 5 %

– single harmonic: 3 %

NOTE – Attention is drawn to the possibility that under certain operating conditions the power factor may be less than the rated value, and that this can affect the voltage regulation.

4.3.3.2 Transient conditions

When the generator is driven at rated speed, giving its rated voltage, and is subject to a sudden change of symmetrical load within the limits of a specified current and power factor, the voltage shall not fall below 85 % nor exceed 120 % of the rated voltage.

The voltage of the generator shall then be restored to within ±3 % of the rated voltage, for the main generator set in not more than 1,5 s. For emergency sets these values may be increased to ±4 % in not more than 5 s respectively (see 4.3.3.4).

In the absence of precise information concerning the maximum values of the sudden loads, the following conditions shall be assumed: 60 % of the rated current with a power factor of between 0,4 lagging and 0 to be thrown on with the generator running at no load, and then withdrawn after steady-state conditions have been reached.

NOTE 1 – For the purpose of verifying the above conditions, the generator under test may be driven by a suitable electric motor at practically constant speed.

NOTE 2 – To achieve satisfactory performance on board a unit, the governor of the prime-mover must restore the speed to a steady state within the limits specified in 4.10.3 in not more than 3 s.

NOTE 3 – For gas-driven machines and turbines, other values may be applicable. Advice can be found in ISO 8528-5.

4.3.3.3 Steady short-circuit conditions

Under steady short-circuit conditions, the generator with its excitation system shall be capable of maintaining a current of at least three times its rated value for a duration of up to 2 s, unless protection selectivity conditions exist which allow a shorter duration and provided that, in any case, the safety of the installation is ensured.

4.3.3.4 Emergency generators

Emergency generator sets which are required to meet the same general requirements as in 4.3.3.2 need only maintain the steady-state voltage within 3,5 %, and during transient conditions to recover their voltage within 4 % in not more than 5 s.

4.4 Generators for special purposes

4.4.1 DC generators

Special purpose d.c. generators, together with their excitation system, shall have such voltage characteristics as are required.

4.4.2 AC generators

Special purpose a.c. generators and general service generators rated less than 50 kVA, together with their excitation system, shall have the voltage characteristics agreed upon between manufacturer and purchaser.

4.5 Parallel operation of general service generators – DC generators

4.5.1 Stability

DC generators which are required to run in parallel shall be stable in operation at all loads from no load to full load.

4.5.2 Load sharing

The design of d.c. generators and their connections shall be such that, when they operate in parallel, the individual load on each machine does not normally differ from the theoretical load (proportional to rating) by more than 12 % of the rated full load of the largest machine, or more than 25 % of the rating of the individual machine concerned. This requirement applies when the combined load on the sets is varied between 20 % and 100 % of the combined rating. Such a load sharing shall not result in overloading the smaller set.

4.5.3 Voltage drop

For each generator of a group required to run in parallel, the voltage drop across the series fields and its connection to the switchboard (which may incorporate a resistor) shall be approximately equal.

4.6 Parallel operation of general service generators – AC generators

4.6.1 Reactive load sharing

When a.c. generators are operated in parallel, the reactive load of the individual generating sets shall not differ from their proportionate share of the total reactive load by more than 10 % of the rated output of the largest machine, or more than 25 % of the smallest machine where this value is lower than the former.

NOTE – The alternator design should incorporate sufficient damping in the rotor circuits to avoid power oscillations and instability when running in parallel.

4.6.2 Load sharing

For a.c. generating sets operating in parallel, the governing characteristics of the prime-movers shall be such that, within the limits of 20 % and 100 % total load, the load on any generating set does not normally differ from its proportionate share of the total load by more than 15 % of the rated output of the largest machine, or more than 25 % of the rating of the individual machine concerned.

The facilities for adjusting the governor at normal frequency shall be sufficiently accurate to permit a minimum adjustment of the load on the engine not exceeding 5 % of the rated load (see also note 2 of 4.3.3.2).

NOTE – It is assumed that the speed of the prime-mover decreases with the application of the load and increases with its removal, permanent variation being such that the speed does not at any load vary from the straight line joining rated load and no load by more than one-fifth of the maximum permanent speed variation involved.

4.6.3 Flywheel effect for a.c. generating sets

For a.c. generators operating in parallel, the combined flywheel effect of the flywheel and alternator shall be such that the angular deviation in either direction, from the position of uniform rotation, does not at any time exceed 3,5 electrical degrees, in addition to complying with the limit of cyclic irregularity given in 4.11.

The engine manufacturer shall inform the supplier of the alternator as to the total flywheel effect which he considers should be provided to ensure that the maximum calculated angular deviation of 3,5 electrical degrees is not exceeded. The engine manufacturer shall be responsible for achieving the necessary flywheel effect.

The engine manufacturer shall also state the frequencies of such engine-disturbing forces as are of significant magnitude and the supplier of the alternator shall then specify to the engine manufacturer what additional flywheel effect, if any, is necessary in order to avoid the effects of electromechanical resonance (due to the vibration of the generator).

The generator manufacturer shall provide all necessary information to the engine manufacturer who will be responsible for checking the whole system for critical speeds and for calculating the torsional rigidity and torsional strength of the complete shaft system. The engine manufacturer shall state what reasonable changes, if any, in generator shafting are necessary to avoid excessive stresses from occurring, and such changes shall be undertaken by the generator manufacturer.

NOTE 1 – The angular deviation specified is that calculated on the assumption that the torque of the alternator, i.e. the torque opposing the motion of the engine, is uniform throughout the engine cycle.

NOTE 2 – The angular deviation specified applies to alternators for ordinary regulation. Alternators designed for special regulation may require still closer uniformity of rotation.

NOTE 3 – Avoidance of effects of resonance means that the natural frequency of oscillation of the alternator with its flywheel, when connected to the electrical system with which it is to work in parallel, should not approach a frequency of any engine impulses of significant magnitude.

4.7 Control and excitation of generators

4.7.1 Field regulation of d.c. generators

Means shall be provided at the switchboard to enable the voltage of each generator to be adjusted separately. The equipment provided shall be capable of adjusting the voltage of the d.c. generator to within 0,5 % of the rated voltage for machines above 100 kW and 1 % of the rated voltage for smaller machines, at all loads between no load and full load, with the d.c. generator coupled to its prime mover at any permissible temperature within the working range. The regulator shall be capable of reducing the no-load voltage to 10 % below the voltage when the generator is cold.

4.7.2 Polarity of series windings

The series windings of each two-wire generator shall be connected to the negative terminal of each machine.

4.7.3 Equalizer connections

Each equalizer connection shall have a cross-sectional area not less than half that of the negative connection from the generator to the switchboard.

4.7.4 Excitation of a.c. generators

The components of the excitation system, including the automatic voltage regulator if used, shall be of a type suitable for offshore conditions and shall be capable of operating under all specified conditions of steady and transient load, including short circuit, as stated in 4.3.3.1, 4.3.3.2 and 4.3.3.3.

When it is intended to operate two or more generators in parallel, means shall be provided to divide the reactive power properly between the generators (see 4.6.1).

NOTE – It is desirable to ensure that failure of the excitation system (including the automatic voltage regulator if used) does not cause damage to the installation.

4.8 Mechanical features (generators and motors)

4.8.1 Entry of water

Where water cooling is used, the cooler shall be so designed as to avoid entry of water into the machine, whether by leakage or condensation in the heat-exchanger.

4.8.2 Accumulation of moisture and condensation

Consideration shall be given to providing effective means to prevent accumulation of moisture and condensation within the machines, especially when these are idle for appreciable periods, for example by means of space heaters.

4.8.3 Balance

Machines shall be constructed so that, when running at any and every working speed, all revolving parts are well balanced.

4.8.4 Shaft currents

Measures shall be taken, if necessary, to prevent the circulation of current between the shaft and the bearings.

4.8.5 Terminals

Suitable terminals, clearly marked, shall be provided in an accessible position, convenient for external connections. The terminals shall be effectively secured and shall be so spaced and/or shielded that they cannot accidentally be earthed, short-circuited or touched.

4.9 Lubrication (generators and motors)

4.9.1 Generators and motors shall have efficient and continuous lubrication at all running speeds and all normal working bearing temperatures, with any variation of the inclination of the unit from normal as specified in the future IEC 61892-5.[1)] For additional requirements for emergency generators, see future IEC 61892-2[2)].

4.9.2 Means shall be provided to prevent the lubricant from creeping along the shaft or otherwise gaining access to the insulation of the machine or to any live part thereof.

4.9.3 Each oil-lubricated bearing shall be provided with a suitable overflow which, while permitting efficient lubrication when the machine is running, prevents the bearing from containing an excess of oil.

4.9.4 Where ring lubrication is employed, the rings shall be so constrained that they cannot leave the shaft.

4.9.5 Each self-lubricated sleeve bearing shall be fitted with an inspection lid and means for the visual indication of oil level or the use of an oil-gauge. This requirement does not apply to machines under 100 kW (d.c.) or 100 kVA (a.c.).

4.10 Prime movers

4.10.1 General

Prime-mover-driven generators intended to supply power to services specified in the future IEC 61892-2[2)] shall have a rating and overload capacity compatible with the rating and the specified overload capability of the driven generators.

4.10.2 Turbine-driven d.c. generating sets in parallel

Where a turbine-driven d.c. generator is arranged to run in parallel with other generators, a switch shall be fitted on each turbine emergency governor for the purpose of opening the generator circuit-breaker when the emergency governor is functioning. The contacts of the overspeed switch shall normally be closed.

4.10.3 Speed governing characteristics

Speed governors on prime-movers shall be such that they will automatically maintain the speed within a transient variation of 10 %, and have a steady-state variation not exceeding 5 % when the rated load is suddenly thrown off and 50 % of the load is suddenly thrown on, followed after a short instant by the remaining 50 % of the load, unless other sudden load changes are specified.

Consideration may be given to the throwing on of loads in portions, of which the values differ from those stated above, in order to reach the 100 % rated load condition.

However, application of the load in more than two steps shall only be permitted if the conditions within the unit's supply permit the use of such prime-movers which can only be loaded in more than two load steps, and provided that this has already been allowed for at the design stage.

---

1) In preparation. Before IEC 61892-5 is published, see IEC 60092-505.

2) In preparation. Before IEC 61892-2 is published, see IEC 60092-201.

Each prime-mover shall be fitted with an emergency overspeed protection device which will operate at a speed not exceeding 15 % of the rated speed, and which has a provision for tripping by hand.

Where the driven generators are required to operate in parallel, the governing characteristics shall comply with the requirements of 4.5.2 and 4.6.2.

NOTE 1 – See also IEC 60092-101 and ISO 8528-5.

NOTE 2 – For emergency generators, see also IEC 61892-2 (in preparation).

4.10.4 Flywheel effect

The flywheel effect provided shall comply with the requirements of 4.6.3.

4.11 Cyclic irregularity

The maximum permissible cyclic irregularity in a reciprocating engine throughout one engine cycle shall conform to the requirements given hereafter.

4.11.1 For an engine with one or two cylinders, the cyclic irregularity shall not be worse than 1/75 unless a closer limit is specified.

4.11.2 For an engine with more than two cylinders, the cyclic irregularity shall not be worse than the values given in table 1.

Table 1 – Limits of cyclic irregularity

Number of engine impulses per second *f*	Cyclic irregularity to be not worse than
Up to 4	1/150
6	1/220
8 to 20	1/(200/f – f)
Above 20	1/75
NOTE – Cyclic irregularity is defined as the ratio of the maximum variation in angular velocity at the flywheel during one engine cycle to the mean angular velocity when the engine is running at any load up to and including rated load and at rated speed. This is conveniently expressed as follows: $\frac{\text{Max. speed} - \text{Min. speed}}{\text{Mean speed}}$	

4.12 Lubrication (prime movers)

4.12.1 Prime movers shall be efficiently and continuously lubricated at all running speeds and at all working oil temperatures without risk of spilling oil, at any inclination of the installation from the normal specified in the future IEC 61892-5[1)] .

4.12.2 Turbine-driven generating sets dependent on forced lubrication shall be arranged to shut down automatically in case of failure of lubrication, and effective lubrication shall be provided to prevent damage to the bearings during running down.

[1)] In preparation. Before IEC 61892-5 is published, see IEC 60092-101.

4.13 Running speed

The normal speed on a combined generating set shall not approach critical speed.

4.14 Testing

Sufficient tests shall be made in accordance with IEC 60034-1, unless otherwise specified (see 4.2.1), in order to ensure that the machine meets these requirements.

4.15 Degree of protection provided by enclosures

Equipment shall be enclosed and have a degree of protection appropriate for the environment in which it is used.

NOTE 1 – See IEC 61892-2 (in preparation).

NOTE 2 – For classification of degrees of protection provided by enclosures for rotating electrical machines, see IEC 60034-5.

4.16 Rating plates

In addition to the specifications to which the machine conforms, all machines shall have a rating plate bearing the appropriate indications, as required by the following list. However, these items need not all feature on the same plate.

List of indications to feature on the rating plate:

1) the manufacturer's name;
2) the manufacturer's serial number, or identification mark, and year of manufacture;
3) the type of machine; motor or generator, shunt, series, compound, cage, etc.;
4) rating class according to section three of IEC 60034-1. The duration and sequence may be indicated by a qualifying term;
5) the rated output;
6) the rated voltage;
7) the rated current;
8) type of current (d.c. or a.c.);
9) for a.c. machines, the rated frequency and number of phases;
10) the rated speed or speed range;
11) the permissible overspeed, if applicable (e.g. for turbine-type driven generators);
12) the class of insulation or the permissible temperature rise;
13) the number and date of the specification (for example IEC 60034-1);
14) for a.c. machines, the winding connections designated by the appropriate symbols from IEC 60617;
15) for a.c. machines, the power factor;
16) for synchronous machines or d.c. machines with separate excitation, the rated excitation current and voltage;
17) for wound-rotor induction machines, the open-circuit voltage between slip-rings and the slip-ring current for rated conditions;
18) the ambient temperature.

NOTE – The above items are numbered for convenient reference, but the order in which they appear on the rating plate is not standardized.

Table 2 – Limits of temperature rise of air-cooled machines based on an ambient temperature of 50 °C

Item no.	Part of machine	Class of insulation														
		A			E			B			F			H		
		Method			Method			Method			Method			Method		
		Therm °C	Res. °C	E.T.D. °C (see note 2)	Therm °C	Res. °C	E.T.D. °C	Therm °C	Res. °C	E.T.D °C	Therm °C	Res. °C	E.T.D. °C	Therm °C	Res °C	E.T.D. °C
1	– AC windings of machines with an output of 5 000 kW (or kVA) or more, or with a core length of 1 m or more NOTE – The E.T.D. method may be used in machines having an output less than 5 000 kW (or kVA) or having a core length less than 1 m, but the limits of temperature rise given in this item shall apply.	–	50	50	–	60	60	–	70	70	–	90	90	–	115	115
2	– AC windings with outputs less than 5 000 kW (or kVA) or with a core length less than 1 m – Field windings of a.c. and d.c. machines with an excitation other than those in items 3 and 4 – Windings of armatures with commutators	40	50	–	55	65	–	60	70	–	75	90	–	95	115	–
3	– Field windings of turbine-type machines with d.c. excitation	–	–	–	–	–	–	–	80	–	–	100	–	–	–	–
4	– Low-resistance field windings of more than one layer, and compensating windings – Single-layer windings with exposed bare or varnished metal surfaces[1)]	50 55	50 55	– –	65 70	65 70	– –	70 80	70 80	– –	90 100	90 100	– –	115 125	115 125	– –

Table 2 – *Concluded*

Item no.	Part of machine	Class of insulation														
		A			E			B			F			H		
		Method			Method			Method			Method			Method		
		Therm °C	Res. °C	E.T.D. °C	Therm °C	Res. °C	E.T.D. °C	Therm °C	Res. °C	E.T.D. °C	Therm °C	Res. °C	E.T.D. °C	Therm °C	Res. °C	E.T.D. °C
5	– Permanently short-circuited insulated windings	50	–	–	65	–	–	70	–	–	90	–	–	115	–	–
6 7	– Permanently short-circuited uninsulated windings – Magnetic core and others not in contact with windings[4)]	The temperature rise of these parts shall in no case reach such a value that there is a risk of injury to any insulating material or other material on adjacent parts.														
8	– Magnetic core and other parts in contact with windings	50	–	–	65	–	–	70	–	–	90	–	–	115	–	–
9	– Commutators and slip-rings[2)] open or closed	50	–	–	60	–	–	70	–	–	80	–	–	90[4)]	–	–

[1)] This also includes multiple-layer windings provided that the underlayers are in contact with the circulating coolant.

[2)] The temperature rises given in item 9 are permissible provided that insulation appropriate to the temperature rise is used, except when the commutator or slip-ring is adjacent to the windings, in which case the temperature rise shall not exceed that for the winding insulation class. The values of temperature rises given apply only to measurements made by bulb thermometers.

[3)] Special precautions may be necessary for temperature rises of 90 °C when choosing brush grades.

NOTE 1 – Classes F and H shall only be used after agreement between manufacturer and purchaser.

NOTE 2 – a) *Embedded temperature detector (E.T.D.) method*

Embedded temperature detectors are resistance thermometers or thermocouples built into the machine during construction at points which are inaccessible after the machine is completed.

b) *Methods of temperature measurement by embedded temperature detectors*

When the E.T.D. method is used, at least six detectors, suitably distributed round the stator, should be built into the machine. All reasonable efforts, consistent with safety, shall be made to place the detectors at the various points at which the highest temperatures are likely to occur, in such a manner that they are effectively protected from contact with the coolant.

– *Two coil-sides per slot*

When the winding has two coil-sides per slot, each detector shall be located between insulated coil-sides within the slot.

– *More than two coil-sides per slot*

When the winding has more than two coil-sides per slot, each detector shall be located between insulated coil-sides in positions at which the highest temperatures are likely to occur.

NOTE 3 – If air-to-water heat exchangers are used, the temperature rise will be specified with respect to the temperature of the cooling water at the inlet of the cooler. In this case, the temperature rises of table 2 are increased by 20 °C, but only if the specified inlet water temperature does not exceed 30 °C. When the commutators of these machines are not in the enclosed air circuit cooled by the water cooler, but are cooled by the ambient cooling air, the permissible temperature rise above the ambient cooling air is the same as for ventilated machines.

NOTE 4 – Where a machine is designed to operate with a coolant at the approximately ambient temperature of 50 °C, the permissible temperature rises may be reduced or increased in accordance with the given ambient temperature. The permissible temperature rises must be taken to the nearest whole Celsius degree.

Table 3 – Dielectric tests

No.	Machine or parts	Test voltages (r.m.s.)
1	Insulated windings of rotating machines of less than 1 kW or 1 kVA, and of rated voltage less than 100 V, with the exception of those in items 4 to 8	500 V + twice the rated voltage
2	Insulated windings of rotating machines of size less than 10 000 kW or kVA or more, with the exception of those in item 1 and in items 4 to 8 (see note 2).	1 000 V + twice the rated voltage with a minimum of 1 500 V (see note 1)
3	Insulated windings of rotating machines of 10 000 kW or kVA or more, with the exception of those in items 4 to 8 (see note 2). Rated voltage (see note 1): – U up to 2 000 V – U from 2 000 V to 6 000 V – U from 6 000 V to 17 000 V – U above 17 000 V	 1 000 V + 2 U 2,5 U 3 000 V + 2 U Subject to special agreement
4	Separately-excited field windings of d.c. machines	1 000 V + twice the maximum rated circuit voltage with a minimum of 1 500 V
5	Field windings of synchronous generators, synchronous motors and synchronous condensers	
a)	Field windings of synchronous generators	10 times the rated excitation voltage with a minimum of 1 500 V and a maximum of 3 500 V
b)	When a machine is intended to be started with the field winding short-circuited or connected across a resistance less than 10 times the resistance of the winding	10 times the rated excitation voltage with a minimum of 1 500 V and a maximum of 3 500 V
c)	When the machine is intended to be started either with the field winding connected across a resistance of value equal to, or more than, 10 times the resistance of the winding, or with the field windings on open circuit or without a field-dividing switch	1 000 V + twice the maximum value of the r.m.s. voltage, which can occur under the specified starting conditions, between the terminals of the field winding, or in the case of a sectionalized field winding, between the terminals of any section, with a minimum of 1 500 V (see note 3)
6	Secondary (usually rotor) windings of induction motors or synchronous induction motors if not permanently short-circuited (e.g. if intended for rheostatic starting)	
a)	For non-reversing motors or motors reversible from standstill only	1 000 V + twice the open-circuit standstill voltage as measured between slip-rings or secondary terminals with rated voltage applied to the primary windings
b)	For motors to be reversed or braked by reversing the primary supply while the motor is running	1 000 V + four times the open-circuit standstill secondary voltage as defined in item 6a)
7	Exciters (except as below)	As for the windings to which they are connected
	Exception 1 – Exciters of synchronous motors (including synchronous induction motors) if connected to earth or disconnected from the field winding during starting	1 000 V + twice the rated exciter voltage, with a minimum of 1 500 V
	Exception 2 – Separately excited field windings (see Item 4)	
8	Assembled group of machines and apparatus	A repetition of the tests in items 1 to 7 above should be avoided if possible, but if a test on an assembled group of several pieces of new apparatus is made, each one of which has previously passed its high-voltage test, the test voltage to be applied to such assembled group shall be 80 % of the lowest test voltage appropriate for any part of the group (see note 4)

NOTE 1 – For two-phase windings with one terminal in common, the rated voltage used to calculate the test voltage shall be taken as 1,4 times the voltage of each separate phase.

NOTE 2 – High-voltage tests on machines with graded insulation shall be the subject of special agreement.

NOTE 3 – The voltage occurring between the terminals of the field windings, or sections thereof, under the specified starting conditions may be measured at any convenient reduced supply voltage, and the voltage so measured is increased in the ratio of the specified starting supply voltage to the test supply voltage.

NOTE 4 – For windings of one or more machines connected together electrically, the voltage to be considered is the maximum voltage that occurs in relation to earth.

5 Transformers for power and lighting

5.1 General

The provisions of this clause are applicable to all transformers used for power, lighting and static convertors and, where appropriate, to starting transformers, static balancers, saturable reactors and transductors for use in offshore units, including single-phase transformers rated at less than 1 kVA, and three-phase transformers rated at less than 5 kVA, unless special requirements are specified. All equipment referred to shall comply with the relevant requirements of IEC 60076-1, IEC 60076-2, IEC 60076-3, IEC 60076-3-1, IEC 60076-5, as well as with the additional requirements given in this standard.

Transformers for use with convertors, invertors, variable speed drives, etc., shall be so designed as to be suitable for use on non-sinusoidal supplies and/or variable frequency supplies, and shall comply with IEC 60146-1-3.

5.2 Winding arrangement

Transformers shall be double-wound (two separate windings). Starting transformers may be of the auto-transformer type.

NOTE – For special equipment other winding arrangements may be used.

5.3 Terminals

Suitable terminals, clearly marked, shall be provided in an accessible position, convenient for external connections. The terminals shall be effectively secured and shall be so spaced and/or shielded that they cannot be accidentally earthed, short-circuited or touched.

5.4 Cooling arrangements

5.4.1 When installed indoors, transformers shall preferably be of the dry, air-cooled type.

NOTE – In some countries oil-filled equipment is not permitted on offshore units.

5.4.2 Transformers of the liquid-immersed type shall preferably be hermetically sealed. If of the conservator type, they shall be so designed that they operate without risk of spilling liquid under all conditions, with the offshore units inclined from the normal as specified in the future IEC 61892-5[1)] . If provision is made for breathing, a suitable dehydrator shall be provided.

5.4.3 For liquid-immersed type transformers, consideration shall be given to the possibility of providing over-temperature alarm and gas-actuated protection devices.

NOTE – Regarding installation precautions, see the future IEC 60092-401 and IEC 61892-6.

5.4.4 Liquid cooled transformers shall use a non-toxic coolant which does not readily support combustion.

5.4.5 Where forced cooling is used, it shall be possible to operate at reduced power on failure of a pump or a fan. Consideration shall be given to the provision of suitable indicating and alarm facilities.

---

1) In preparation. Before IEC 61892-5 is published, see IEC 60092-505.

5.5 Voltage regulation

The voltage drop in the secondary voltage between no load and rated load shall be agreed between the purchaser and the manufacturer.

NOTE – When determining the transformer ratio and the short-circuit impedance, consideration should be given to total voltage drop to be expected in the supply and distribution system. In this respect, see also IEC 61892-2[1)].

5.6 Parallel operation

When transformers are so arranged that their secondary windings may be connected in parallel, their winding connections shall be compatible, their rated voltage ratios shall be equal (with tolerances allowed) and their short-circuit impedance values, expressed as a percentage, shall have a ratio within 0,9 to 1,1. When transformers are intended for operation in parallel, the rated power of the smallest transformer in the group shall be not less than half of the rated power of the largest transformer in the group.

5.7 Temperature-rise limits

Temperature-rise limits shall be defined in accordance with IEC 60076-2, taking into consideration the ambient temperatures referred to in IEC 61892-1[2)].

5.8 Tests

If a short-circuit test is required to prove the short-circuit ability of a transformer, it will be a type test and shall comply with 2.2.5 of IEC 60076-5.

6 Switchgear and controlgear assemblies

6.1 General

The provisions of this clause are applicable to switchgear and controlgear assemblies, with 6.3 to 6.8 containing provisions for rated voltages not exceeding 1 000 V a.c. at rated frequencies not exceeding 60 Hz or 1 500 V d.c., while the provisions of 6.9 are applicable for voltages in the range from 1 kV up to and including 15 kV at rated frequencies not exceeding 60 Hz.

NOTE – For voltages above 15 kV national standards may be applicable.

6.2 Definitions

For definition of general terms used in this clause, see IEC 60050(441), and IEC 60439-1 (see also clause 3).

6.3 Classification of assemblies

See clause 3 of IEC 60439-1.

6.4 Electrical characteristics of assemblies

See clause 4 of IEC 60439-1.

---

1) In preparation. Before IEC 61892-2 is published, see IEC 60092-201.

2) In preparation. Before IEC 61892-1 is published, see IEC 60092-101.

6.5 Information to be given regarding the assemblies

6.5.1 Nameplates

Each assembly shall be provided with one or more plates, marked in a durable manner and located in a visible place so that they are legible once the assembly is installed.

Information specified under a) and b) shall be given on the nameplate.

Information from items c) to r) may, where applicable, be given either on the nameplate or in the technical documentation of the manufacturer.

a) the manufacturer's name or trade mark;

NOTE – The manufacturer is deemed to be the organization taking the responsibility for the complete assembly.

b) type designation or identification number or other means of identification making it possible to obtain relevant information from the manufacturer;

c) IEC 61892-3;

d) type of current (and frequency in case of a.c.);

e) rated operational voltages;

f) rated insulation voltages and rated impulse withstand voltage, when stated by the manufacturer;

g) rated voltages of auxiliary circuits (if applicable);

h) limits of operation, see clause 4 of IEC 60439-1;

j) rated current of each circuit;

k) short-circuit withstand strength;

l) degree of protection;

m) measures for personal safety;

n) service conditions for indoor use, outdoor use or special use, if different from the usual conditions as given in 6.6 and pollution degree, when stated by the manufacturer;

p) types of system earthing for which the assembly is designed;

q) dimensions (not applicable for PTTA) preferably given in order of height, width (or length) and depth;

r) weight (not applicable for PTTA).

6.5.2 Markings

Inside the assembly, it shall be possible to identify individual circuits and their protective devices.

Where items of equipment of the assembly are designated, the designations used shall be identical to those on the wiring diagrams which shall be supplied together with the assembly, and shall be in accordance with IEC 61346-1.

6.5.2.1 Circuits

Individual circuits and their devices shall have durable markings with a permanent means of fixing. The setting of protective devices shall be indicated. When, for fuses above 500 V, the fuse holders permit the insertion of fuses of a lower nominal voltage, special warning labels or symbols shall be provided that read, for example: "Caution 690 V fuses only".

NOTE – The rating of fuses and the setting of protective devices may be given in the documentation instead of on the switchboard.

6.5.2.2 Marking of parts

Withdrawable and removable parts of an assembly shall be marked to identify where the parts can be placed in the assembly.

6.5.3 Instructions for installation, operation and maintenance

6.5.3.1 The manufacturer shall specify in his documents or catalogues the conditions, if any, for the installation, operation and maintenance of the assembly and the equipment contained therein.

6.5.3.2 If necessary, the instructions for transport, installation and operation of the assembly shall indicate the measures that are of particular importance for the proper and correct installation, commissioning and operation of the assembly.

6.5.3.3 Where necessary, the above mentioned documents shall indicate the recommended extent and frequency of maintenance.

6.5.3.4 If the circuitry is not obvious from the physical arrangement of the apparatus installed, suitable information shall be supplied, for example wiring diagrams or tables.

6.5.3.5 Where polarized circuit-breakers are installed in d.c. systems, and in all similar cases, warning labels shall be so arranged as to guard against the possibility of incorrect connections during maintenance or replacement.

6.6 Environmental conditions

The normal environmental conditions shall be as stated in IEC 61892-1[1)]. Other environmental conditions shall be agreed between the manufacturer and the user if required, for example for use in arctic or tropical climates.

The conditions specified in IEC 61892-1[1)] shall take precedence over values given in 6.1 to 6.3.1 of IEC 60439-1.

6.7 Design and construction

6.7.1 Mechanical design

6.7.1.1 General

The assemblies shall be constructed using only materials capable of withstanding the mechanical, electrical and thermal stresses, as well as the effects of humidity which are likely to be encountered in normal service.

Protection against corrosion shall be ensured by the use of suitable materials or by the application an equivalent protective coating to the exposed surface, taking account of the intended conditions of use and maintenance.

All enclosures or partitions shall be of a mechanical strength sufficient to withstand the stresses to which they may be subjected in normal service, and shall be of a type suitable for offshore conditions.

[1)] In preparation. Before IEC 61892-1 is published, see IEC 60092-101.

The apparatus and circuits in the assembly shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

For parts of an assembly which are made of insulating materials, resistance to heat, fire and tracking (if applicable) shall be verified according to 8.2.8 of IEC 60439-1. This verification is not needed for parts which are tested according to their own specifications.

6.7.1.1.1 Structural parts of aluminium alloy

If structural parts and/or busbars are of aluminium alloy, the material shall be suitable for use in the marine environment and precautions shall be taken to avoid galvanic corrosion.

6.7.1.1.2 Insulating material

The insulating material shall be in accordance with the general requirements as stated in IEC 61892-1[1)].

6.7.1.1.3 Section and distribution boards

Enclosures shall be made of flame-retardant material and so constructed or located that they can be opened only by authorized personnel.

6.7.1.1.4 Handrails or handles on mobile units

Every main or emergency switchboard shall be provided with an insulated handrail, located on a fixed part, or insulated handles suitably fitted on the front of the switchboard. Where access to the rear of above mentioned switchboards is necessary for operational or maintenance purposes, an insulated handrail, located on a fixed part, or insulated handles shall be fitted. It may be necessary to provide handrails or handles for section boards, if the dimensions are similar to main or emergency switchboards.

6.7.1.1.5 Door locking

Doors on which electrical equipment is fitted, which is live when the doors are open, shall be provided with locking facilities for the open position.

6.7.1.2 Clearance, creepage distances and isolating distances

See clause 7.1.2 of IEC 60439-1. In addition, 6.7.1.2.1 to 6.7.1.2.1.2 shall be applied.

6.7.1.2.1 Clearance and creepage distances

Clearance and creepage distances shall be in accordance with 6.7.1.2.2 type-tested and partially type-tested assemblies. For non-type-tested assemblies, clearance and creepage distances shall be in accordance with 6.7.1.2.3. The clearance and creepage distances between busbars and/or connectors other than cables in assemblies shall not be permanently reduced below the values specified in 6.7.1.2.2 or 6.7.1.2.3 due to abnormal conditions (for example short circuits).

[1)] In preparation. Before IEC 61892-1 is published, see IEC 60092-101.

6.7.1.2.2 Type-tested and partially type-tested assemblies

For these assemblies the following requirements for the clearance and creepage distances of busbars shall apply:

- pollution degree 3: (conductive pollution occurs, or dry, non-conductive pollution occurs, which becomes conductive due to expected condensation);
- overvoltage category III: (distribution circuit level);
- inhomogeneous field conditions (case A);
- rated operational voltage 1 000 V a.c., 1 500 V d.c.;
- group of insulation material III a.

As a result of these requirements the values are as follows:

- minimum clearance: 8 mm
- minimum creepage distance: 16 mm

If a pollution degree higher than 3 is applicable because of the location of the assembly, e.g. in diesel-engine rooms, the requirements shall be as stated in 6.7.1.2.3.

NOTE – The above mentioned clearances and creepage distance are the minimum values.

6.7.1.2.3 Non type-tested assemblies

For these assemblies the requirements for the clearance and creepage distances shall be as stated in table 4.

The values in table 4 apply to clearance and creepage distances between live parts and between live and exposed conductive parts.

Table 4 – Clearance and creepage distances for non type-tested assemblies

Rated insulation voltage a.c. r.m.s. or d.c. V	Minimum clearance mm	Minimum creepage distances mm
≤250	15	20
>250 and ≤690	20	25
>690	25	35

6.7.2 Enclosure and degree of protection

See 7.2 of IEC 60439-1.

6.7.3 Temperature rise

See 7.3 of IEC 60439-1.

NOTE – It is recommended that facilities for thermographic inspection or the use of thermostrips are provided to support inspections/surveys during operation of a unit.

6.7.4 Protection against electric shock

See 7.4 of IEC 60439-1. For generally accepted protective measures refer to IEC 60364-4-41.

6.7.4.1 Protection against both direct and indirect contact – Protection by safety extra-low voltage

See 411.1 of IEC 60364-4-41.

6.7.4.2 Protection against direct contact

Protection against direct contact can be obtained either by appropriate constructional measures on the assembly itself, or by additional measures to be taken during installation; this may require information from the manufacturer.

NOTE – An example of additional measures to be taken is the installation of an open-type assembly without further provisions in a location where access is only permitted to authorized personnel.

One or more of the protective measures defined below shall be selected, taking into account the requirements laid down in the following subclause. The choice of the protective measures shall be subject to an agreement between manufacturer and user.

For rated operational voltages above the safety extra-low voltage of 50 V a.c. r.m.s. or d.c. as specified in IEC 61892-1[1)], assemblies shall have a degree of protection against direct contact of at least IPXXB according to IEC 60529.

Means for isolation of generator circuit breakers shall be provided to permit safe maintenance while the main busbars are alive.

NOTE – The provision of means for isolation for other important parts of assemblies is recommended.

6.7.4.3 Protection against indirect contact

See 7.3.4 of IEC 60439-1.

6.7.5 Short-circuit protection and short-circuit withstand strength

See 7.5 of IEC 60439-1.

Reference is made to the future IEC 61892-2[2)], and IEC 60363.

Precautions shall be taken to prevent the escape of gases from internal short-circuits through the front or into adjacent cubicles of the assemblies.

6.7.6 Switching devices and components installed in assemblies

See 7.6 of IEC 60439-1.

6.7.6.1 Selection of switching devices and components

6.7.6.1.1 Design of switching devices/installation of components

Each switching device shall be designed and arranged in such a way that, in the off position, it cannot accidentally move sufficiently to close the circuit.

Wherever possible, components of main circuits with different nominal voltages shall be installed separately from each other.

[1)] In preparation. Before IEC 61892-1 is published, see IEC 60092-101.

[2)] In preparation. Before IEC 61892-2 is published, see IEC 60092-201.

6.7.6.1.2 Instruments for assemblies

6.7.6.1.2.1 Instruments for a.c. generators

Each a.c. generator shall be at least provided with the following instruments:

- a voltmeter for measuring each phase and between each phase and neutral (when applicable);
- an ammeter for measuring each phase;
- a three-phase wattmeter for generators rated more than 50 kVA, if parallel operation is possible;
- a frequency meter.

NOTE – For voltmeters and ammeters, change-over switches can be used to connect an instrument to the different phases (or to neutral).

6.7.6.1.2.2 Instruments for d.c. power sources

For each d.c. power source (e.g. generators, convertors, rectifiers and batteries) a voltmeter and an ammeter shall be provided, except for d.c. power sources for starting devices (e.g. starting motor for emergency generators).

6.7.6.1.2.3 Instruments measuring the insulation level to earth

When a distribution system, whether primary or secondary, for power, heating or lighting, with no connection to earth is used (IT-system), a device capable of continuously monitoring the insulation level to earth and giving an audible and visual indication of an abnormally low insulation level shall be provided. A means shall be provided to silence the audible alarm.

6.7.6.1.2.4 Design of instruments

For each assembly, the measuring error of instruments for single consumers shall not exceed 3 % of the full scale value.

The measuring error of instruments for other purposes shall not exceed 1,5 % of the full scale value.

A d.c. power source instrument for both polarities shall be provided.

Voltmeters shall have a measuring range of at least 120 % of rated voltage.

Ammeters shall have a measuring range of at least 130 % of the highest current expected in continuous operation. Ammeters shall be able to withstand the starting current of motors.

Wattmeters shall have a measuring range of at least 120 % of the rated power.

For generators arranged for parallel operation, the measuring range of a three-phase wattmeter shall include at least 15 % reverse power.

For wattmeters using one current circuit only, the measurement of the current of all generators shall be made in the same phase.

Frequency meters shall have a measuring range of at least ±5 Hz around the rated frequency.

6.7.6.1.2.5 Transformers provided for instrumentation, protection and control circuits

Current transformers used for measuring purposes shall have at least accuracy class 1 as stated in IEC 60044-1.

Current transformers used for protective devices shall be suitable for the overcurrent range that is expected may occur.

Current transformers provided for instrumentation, protection and control shall have their secondary windings connected to earth.

6.7.6.1.2.6 Selection of protective devices

The requirements according to IEC 61892-2[1)] are applicable.

6.7.6.1.2.7 Synchronizing devices

For protection against the effects of incorrect synchronization while paralleling generators, at least one blocking device (e.g. a check synchronizer) shall be provided to avoid synchronizing failures or a current limiting reactance.

At least one synchroscope or three synchronizing lamps or equivalent means for manual synchronization shall be provided.

Provision shall be made for manual speed control of the prime mover at the switchboard for manual synchronization.

6.7.6.1.2.8 Speed governor

For a.c. generators arranged to operate in parallel, a device for the remote speed control of each set shall be provided. The device shall allow at least manual control of the frequency from at least 20 % below to at least 10 % above the system rated frequency. The time taken to cover this range shall be sufficient to enable a satisfactory sharing of load.

6.7.7 Internal separation of assemblies by barriers or partitions

See 7.7 of IEC 60439-1.

6.7.7.1 Barriers between generator sections

Where the aggregate capacity of generators connected to the main busbar of an assembly exceeds 100 kVA a.c. or 100 kW d.c., barriers between the generator sections and adjacent sections shall be installed to limit gas propagation through the assembly.

6.7.8 Electrical connections inside an assembly: bars and insulated conductors

See 7.8 of IEC 60439-1. In addition, the requirements listed below apply.

6.7.8.1 Internal wiring

Internal wiring shall be insulated and shall have either stranded or flexible conductors.

[1)] In preparation. Before IEC 61892-2 is published, see IEC 60092-201.

6.7.8.2 Busbars

6.7.8.2.1 Busbar phase or polarity arrangements

Where practicable, consideration shall be given to providing a standard pattern of busbar phase and polarity arrangements, as viewed from the front of the assemblies.

NOTE – Examples for such patterns are:

a) for a.c. switchgear and controlgear assemblies busbar 1, 2, 3 counting from front to rear, top to bottom or left to right;

b) the polarities on d.c. switchgear and controlgear busbars and connections to be positive, neutral, negative, counting from front to rear, top to bottom or left to right.

6.7.8.2.2 Main busbar subdivisions

Where the aggregate capacity of generators connected to a main busbar of an assembly exceeds 100 kVA a.c. or 100 kW d.c., the main busbars of the assembly shall be subdivided into at least two isolated parts which shall normally be connected by removable links or other approved means. As far as possible, the connection of the generators and any other duplicated equipment shall be equally divided between the parts.

6.7.8.3 Cross-sections and current-carrying capacity of main circuits

6.7.8.3.1 General

Busbars shall consist of electrolytic copper for conductive use or of copper-surrounded aluminium alloy. The rating of current-carrying conductors in a main circuit shall be as outlined below.

- Main busbar: 100 % of the current load on the main busbars at the maximum load condition of the busbar concerned.
- Distribution busbars in sections: unless otherwise specified the diversity factors given in IEC 60439-1 shall apply.
- Termination of components: according to the rated current of the circuits and the permissible temperature limits at the terminals.

6.7.8.3.2 Cross-sections and current-carrying capacity of main busbars and distribution busbars in sections

The basis for rating busbars shall be according to IEC 60439-1.

Temperature rise limits, with the following changes:

- 45 °C ambient air temperature (see 8.2.1.6 of IEC 60439-1);
- 45 °C temperature rise under rated current conditions of busbars for NTTA. For TTA and PTTA, 7.3 of IEC 60439-1 shall apply.

NOTE – To limit the air temperature inside assemblies to the design value, in certain cases special provisions may be necessary, for example natural or forced ventilation.

6.8 Test specifications

6.8.1 Classification of tests

See 8.1 of IEC 60439-1.

6.8.2 Type tests

See 8.2 of IEC 60439-1.

6.8.2.1 Verification of dielectric properties

See 8.2.2 of IEC 60439-1.

In addition, for the verification of dielectric properties of type-tested assemblies, the test voltages stated in tables 10 and 11 of IEC 60439-1 shall be selected.

6.8.2.2 Verification of short-circuit withstand strength

See 8.2.3. of IEC 60439-1.

In addition, except for type-tested assemblies, the short-circuit withstand strength of busbars may be verified by calculation on the basis of IEC 60865-1.

6.8.3 Routine tests

The routine test shall be carried out on any kind of assemblies according to 8.3 of IEC 60439-1 and this standard.

6.8.3.1 Inspection of the assembly including inspection of wiring and if necessary, electrical operation test

See 8.3.1 of IEC 60439-1. In addition, the requirements listed below apply.

6.8.3.1.1 Test requirements

For every assembly for which a function test is required (main switchboards, emergency switchboards, switchboards for propulsion plants), the functions of all mechanical components and the function of the electrical control shall be verified to be in accordance with the functional diagrams

6.8.3.1.2 Electrical function test

The following shall be verified in detail:

- function of the switching devices (switching, interlocking) after installation;
- function of indicating, monitoring and protecting devices;
- assessment of protective measures.

6.8.3.2 Dielectric test

See 8.3.2 of IEC 60439-1.

6.8.3.2.1 General

All electric equipment of the assembly shall be connected for the test, except apparatus which, according to the relevant specifications, is designed for a lower test voltage, and current-consuming apparatus (for example windings, measuring instruments) in which the application of the test voltage would cause the flow of a current, shall be disconnected.

Such apparatus shall be disconnected at one of its terminals unless it is not designed to withstand the full test voltage, in which case all terminals may be disconnected.

6.8.3.2.2 Application, duration and value of test voltage

a) The test voltage according to 6.8.2.2. shall be applied for 1 s. The a.c. source shall have sufficient power to maintain the test voltage irrespective of leakage currents.

   The test voltage shall have a practically sinusoidal waveform and a frequency between 45 Hz and 62 Hz.

   If the equipment included in the main or auxiliary circuits to be tested has previously been subject to a dielectric test, the test voltage shall be reduced to 85 % of the value indicated in 6.8.2.2.

   For the test:

   - either all switching devices shall be closed, or
   - the test voltage shall be applied successively to all parts of the circuit.

   The test voltage shall be applied between the live parts and the frame of the assembly.

b) The test shall be made in accordance with 6.8.2.2. If, in a circuit, components are incorporated which, in accordance with their IEC standards are routine-tested with lower test voltages, these lower voltages shall be used for the test. However, the test voltage shall be not less than 30 % of the rated impulse withstand voltage (without altitude correction factor) or twice the rated insulation voltage, whichever is the higher.

For non type-tested assemblies (NTTA) the test voltage shall be applied for 1 min.

6.8.3.3 Checking of protective measures and of the electrical continuity of the protective circuits

The protective measures with regard to protection against direct and indirect contact shall be checked.

The protective circuits shall be checked by inspection to ensure that the measures prescribed in 7.4.3.1.5 of IEC 60439-1 are met. In particular, screwed connections shall be checked for adequate contact, possibly by random tests.

6.8.3.4 Verification of insulation resistance

For PTTA which have not been subject to a dielectric test according to 6.8.2.2 or 6.8.3.2, an insulation measurement using a measuring device at a voltage of at least 500 V shall be carried out.

In this case, the test is deemed satisfactory if the insulation resistance between circuits and exposed conductive parts is at least 1 000 Ω/V per circuit referred to the nominal voltage to earth of these circuits.

Exceptionally, items which according to their specific requirements are current-consuming components (e.g. windings, measuring instruments) at the application of the test voltage or are not designed for the full test voltage shall be disconnected as appropriate.

6.8.3.5 Measurement of insulation resistance

During the routine test an insulation resistance measurement of the main and auxiliary circuits shall be carried out prior to and following the verification of dielectric properties.

The insulation measurement shall be carried out with at least 500 V d.c. It is allowed to subdivide large assemblies into several sections.

The insulation resistance shall be at least 1 MΩ per section.

6.8.3.6 Verification of temperature-rise limits

The temperature-rise limits shall be verified, by comparison with measurements obtained during tests on similar assemblies and calculations, or if necessary by suitable tests under operating conditions.

6.8.3.7 Use of test data of individual equipment

It is not required that routine tests be carried out on individual equipment of an assembly when it can be verified that the manufacturer of this equipment has already carried out a routine test.

6.9 Switchgear and controlgear in the range above 1 kV up to and including 15 kV

6.9.1 General

High-voltage switchgear shall be constructed in accordance with the following subclauses.

NOTE – In addition, national standards may apply.

High-voltage switchgear shall be of the metal-enclosed type in accordance with IEC 60298, or of the insulation-enclosed type in accordance with IEC 60466.

NOTE – Attention is drawn to the fact that the normal service conditions for insulation-enclosed switchgear according to IEC 60466 include a maximum ambient temperature of 40 °C.

6.9.2 Degrees of protection provided by enclosures

Depending on its location, electrical equipment shall as a minimum have the degree of protection as given in IEC 61892-2[1)], which is in accordance with IEC 60529.

6.9.3 Circuit-breakers, switches and fuses – General

6.9.3.1 Circuit-breakers and switches shall be of the type that minimizes fire hazard.

6.9.3.2 Circuit-breakers shall be in accordance with IEC 60056.

6.9.3.3 Switches shall be in accordance with IEC 60265-1.

[1)] In preparation. Before IEC 61892-2 is published, see IEC 60092-201.

6.9.3.4 Fuses shall be in accordance with IEC 60282.

6.9.3.5 Conduit pipes and valves of compressed-air operating mechanisms shall be of non-corrosive material.

6.9.3.6 If compressed-air-operated circuit-breakers are used, the compressed-air system shall be so designed that switching on is possible only if sufficient switch-off pressure is available for every circuit-breaker on the compressed-air system. Any loss of air pressure shall be indicated.

6.9.3.7 In a compressed-air system, means shall be present to provide clean and dry air. These means shall be duplicated to allow maintenance.

6.9.3.8 Circuit-breakers shall be of the withdrawable type, or with equivalent means or arrangements permitting safe maintenance whilst the busbars are live.

6.9.3.9 Withdrawable circuit-breakers and switches shall be provided with mechanical locking facilities in both service and disconnected positions.

For maintenance purposes, key-locking of withdrawable circuit-breakers and switches and fixed disconnectors shall be possible.

6.9.4 Earthing and short-circuiting

For maintenance purposes, an adequate number of earthing and short-circuiting devices shall be available to enable a sufficient number of circuits to be worked upon with safety. Alternatively, integral means of earthing and short-circuiting may be fitted.

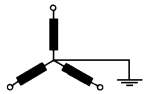
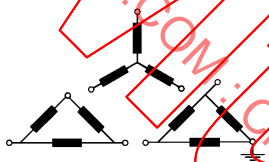
6.9.5 Protection against live parts

The fixed contacts of withdrawable circuit-breakers and switches shall be so arranged that, in the withdrawn position, the live contacts are automatically covered, or full withdrawal is possible only after manual insertion of covers.

6.9.6 Auxiliary systems

If electrical energy and/or physical energy is required for the operation of circuit-breakers and switches, a stored supply of such energy shall be provided for an adequate number of operations.

Table 5 – Correspondence between the nominal voltage of the supply system and the test voltage for type-tested assemblies at sea level
(see table 13 and clause G.1 of IEC 60439-1)

Maximum value of rated operational voltage to earth a.c. r.m.s. or d.c. V	Nominal voltage of the supply system (≤ rated insulation voltage of the equipment) V				Rated impulse withstand voltages U_{imp} kV	Test voltages kV	
	 a.c. r.m.s.	 a.c. r.m.s.	 a.c. r.m.s. or d.c.	 a.c. r.m.s. or d.c.	$U_{1,2/50\ ms}$ a.c. peak and d.c.	$U_{1,2/50\ ms}$ a.c. peak and d.c.	a.c. r.m.s. (46 Hz to 62 Hz)
50	---	---	12,5, 24, 25 30, 42, 48	60-30	0,8	0,95	0,67
100	66/115	66	60	---	1,5	1,8	1,3
150	120/208 127/220	115, 120 127	110, 120	220-110, 240-120	2,5	2,9	2,1
300	220/380, 230/400 240/415, 260/440 277/480	220, 230 240, 260 277	220	440-220	4,0	4,9	3,5
600	347/600, 380/660 400/690, 415/720 480/830	347, 380, 400 415, 440, 480 500, 577, 600	480	960-480	6,0	7,4	5,3
1 000 a.c. 1 500 d.c.	---	660 690, 720 830, 1 000	1 000 a.c. 1 500 d.c.	---	8,0	9,8	7,0

7 Semiconductor convertors

7.1 General

7.1.1 The provisions of this clause are applicable to static convertors using semiconductor rectifying elements such as diodes, reverse blocking triode thyristors, transistors, etc., for use in offshore units. The conversion may be from a.c. to d.c., from d.c. to a.c., from d.c. to d.c. and from a.c. to a.c.

7.1.2 Semiconductor convertors shall comply with the relevant requirements of IEC 60146, IEC 60146-1-1, IEC 60146-1-2, IEC 60146-1-3, IEC 60146-2, IEC 60146-3, as well as with the additional requirements given in this standard.

7.2 Cooling arrangements

7.2.1 Semiconductor convertors shall preferably be of the dry, air-cooled type.

7.2.2 Semiconductor convertors of the liquid-immersed type shall preferably be hermetically sealed. If provision is made for breathing, a suitable dehydrator shall be provided.

7.2.3 Liquid immersed semiconductor devices shall use a non-toxic coolant, which does not combust easily. Consideration shall be given to the provision of a liquid over-temperature alarm and gas actuated protection devices.

NOTE 1 – Regarding installation precautions, see IEC 61892-6.

NOTE 2 – Where a cooling medium for electrical equipment is used, consideration should be given to the detection of leakage in an equipment enclosure and provision of an alarm indication. In addition, the flow of coolant should be monitored to operate an alarm in the event of loss of flow.

7.3 Accessibility

Semiconductor convertor stacks or semiconductor components shall be mounted in such a manner that they may be removed from the equipment without dismantling the complete unit.

7.4 Service conditions

7.4.1 The service conditions, for example ambient temperature, stated in the future IEC 61892-1[1)], are applicable.

7.4.2 If the convertor equipment requires drying for maintenance and inspection purposes, special care shall be taken that the maximum permissible temperature limits are not exceeded when applying heat to the equipment.

7.5 Application

7.5.1 Forced cooling

Where forced cooling is utilized, the circuit shall be so designed that power cannot be applied to, or retained, on convertor stacks or semiconductor components, unless effective cooling is maintained.

NOTE – Reduced power output in natural air cooling mode may be considered.

---

1) In preparation. Before IEC 61892-1 is published, see IEC 60092-101.

7.5.2 Effects from and on the supply or load system

7.5.2.1 Precautions shall be taken to guard the convertor equipment against the harmful effects of overcurrent or overvoltage due to disturbance on the supply or load system, including the effects of regenerated power if the load can operate in such a way.

7.5.2.2 Precautions shall also be taken to guard the supply and the load system against the harmful effects of any disturbance in the convertor itself.

7.5.2.3 Semiconductor convertors shall not cause distortion in the voltage waveform of the power supply to levels exceeding the voltage waveform tolerances at the other user input terminals. This is, in particular, applicable to convertors that employ electronic switches operating once or more than once per cycle of the power supply voltage.

If fitted, filters shall not decrease the insulation resistance between the supply phases and earth to unacceptable levels. In cases where the earth current exceeds 30 mA, isolating transformers shall be fitted.

NOTE 1 – Current harmonics, interacting with the impedance of the supply will generate voltage harmonics. Both the current and voltage harmonics can cause malfunction and overheating in other items of equipment in the unit, if their possible presence has not been taken into account in the equipment design. For systems where a convertor rating is large and a significant proportion of the system rating, it may not be feasible to suppress such harmonics at the source. Consequently, appropriate measures may have to be taken to attenuate these effects on critical equipment. Such measures may include electrical isolation, e.g. MG sets, filters in the supply to critical equipment, correct screening of cables and construction of enclosures, etc.

General guidance is given in IEC 60533.

NOTE 2 – For requirements concerning EMC, see IEC 61892-2 (in preparation).

7.5.3 Diagrams

All applications shall contain schematic and wiring diagrams, or else instruction books shall be provided.

7.6 Nameplate

A nameplate large enough to at least hold the manufacturer's name and the identification number of the equipment shall be used.

7.7 Convertor transformers

If transformers are used in combination with semiconductor convertors on the supply side or the load side of the convertor, these transformers shall comply with the requirements of clause 5.

8 Secondary cells and batteries

8.1 General

This clause 8 is applicable to secondary cells and batteries of the vented type and valve regulated types, which are installed permanently for use in mobile and fixed offshore units.

It is not applicable to batteries of the portable type.

8.2 Types of battery

In general, secondary cells and batteries may be of the lead-acid or nickel-alkaline type, or any other proved type, due consideration having been given to suitability for any specific application.

8.3 Construction and assembly

8.3.1 Access

Secondary cells and batteries shall be arranged to permit ready access for replacing, inspection, testing, replenishing and cleaning.

8.3.2 Vented type secondary batteries

All plates shall be of rigid construction and shall be designed to reduce to a minimum the shedding of active material. The cells for mobile units shall be so constructed as to prevent spilling of electrolyte due to an inclination of 40° from the normal. The filling plugs shall be constructed so as to prevent spilling of electrolyte due to mobile offshore unit movements; such as rolling and pitching.

8.3.3 Valve regulated type secondary batteries

NOTE – For other types of valve regulated secondary cells and batteries, national or other codes should be followed.

8.4 Crates and trays

The secondary cells and batteries shall be grouped in crates or trays of rigid construction and suitable material equipped with handles to facilitate handling.

NOTE – The number of cells in a crate or tray will depend on the weight and on the space available in the installation. The mass of crates or trays should preferably not exceed 100 kg. This clause does not apply to cells whose mass is such that grouping in crates or trays is impracticable.

8.5 Location

Secondary batteries should be located where they are not exposed to excessive heat, extreme cold, spray, steam or other conditions which would impair performance or accelerate deterioration.

NOTE – The best operating conditions for a battery are obtained when the ambient temperature is within the range 15 °C to 20 °C. Sustained ambient temperatures outside this range will affect secondary battery performance and will therefore require special consideration.

8.6 Nameplates

Each crate or tray shall be provided with a durable nameplate securely attached, bearing the manufacturer's name and address and type designation, the ampere-hour rating at a specific rate of discharge (preferably the one corresponding to the duty for the specific application) and the specific gravity of the electrolyte (in the case of a lead-acid battery, the specific gravity when the battery is fully charged).

8.7 Charging facilities

8.7.1 For floating service or for any other conditions where the load is connected to the secondary battery while it is on charge (being charged), the maximum battery voltage under any conditions of charge shall not exceed the safe value of any connected apparatus. The voltage characteristics of the generator or generators, semiconductor convertor or semiconductor convertors, which will operate in parallel with the battery, shall be suitable for each individual application. Where apparatus capable of operation at the maximum charging potential is not available, a voltage regulator or other means of voltage control shall be provided.

8.7.2 Where the voltage of an emergency-lighting secondary battery is the same as that of the unit d.c. supply, the battery may be arranged for charging in two equal sections, a charging resistor being provided for each section.

Alternatively, a booster generator may provide charging voltage. With either method, the arrangement of automatic transfer switching shall be such that emergency supply is available whether the battery is on charge (charged) or not.

8.7.3 Except when a different charging rate is necessary and is specified for a particular application, the charging facilities shall be such that the completely discharged battery can be recharged to 80 % capacity within a period of 10 h.

8.7.4 For secondary batteries which normally stand idle for long periods, trickle charging to neutralize internal losses shall be provided where practicable.

An indication shall be provided to indicate a charging voltage present at the charging unit.

8.7.5 Protection against reversal of the charging current shall be provided.

8.8 Ventilation of secondary battery compartments

For ventilation of battery compartments, see IEC 61892-7.

9 Luminaires

9.1 General

9.1.1 The provisions of this clause are applicable to fixed or portable luminaires for use in offshore units. It does not apply to battery-operated torches.

9.1.2 Luminaires shall comply with the requirements of relevant IEC standards and with the additional requirements included in this standard.

NOTE – The most relevant standards are IEC 60061-2, IEC 60238, IEC 60400, IEC 60529 and IEC 60598.

9.2 Construction

9.2.1 The construction of luminaires shall comply with the requirements of IEC 61892-2[1)] and with the following:

9.2.2 Luminaires shall be so designed and constructed that the passages for the insulated conductors are of ample size and are free from rough projections, sharp angles and abrupt bends. All outlets for cables shall have well-rounded edges or be suitably bushed.

9.2.3 Luminaires shall be so designed and the insulated conductors installed in such a way that they cannot apply stress to any terminal to which they may be connected.

9.2.4 Luminaires shall be so designed and fixed that dust and moisture cannot readily accumulate on live parts and on their insulation.

9.2.5 Current-carrying parts of luminaires shall be insulated from the frame or enclosure.

9.2.6 All metal parts of luminaires shall be electrically connected together and shall be provided with a suitable terminal for earthing. For exceptions see IEC 61892-6, and 9.9 of this part.

9.2.7 Supports of live parts in lampholders shall be at least of flame-retardant material for fluorescent lamps and at least of incombustible material for incandescent lamps.

---

1) In preparation. Before IEC 61892-2 is published, see IEC 60092-201.

9.2.8 The construction of luminaires shall as a minimum have a degree of protection of IP2X according to IEC 60529.

9.2.9 In bathrooms, washplaces, laundries, galleys and other similar places, those parts of a lampholder likely to be touched by a person replacing a lamp shall be constructed of or shrouded in insulating material, and fitted with a protective shield.

NOTE – The use of totally enclosed luminaires is desirable.

9.2.10 Where centre-contact bayonet or Edison screw lampholders are used on single-pole and earthed neutral systems, the outer or screwed contact shall be connected to the neutral conductor.

9.3 Temperature and temperature rise

9.3.1 Luminaires shall be so constructed as to provide adequate dissipation of heat from lamps, ballasts, capacitors, etc.

9.3.2 The temperature of surface parts which can be touched in service shall normally not exceed 60 °C.

9.3.3 The temperature rise of terminals for connection of supply cables shall not exceed 40 °C.

9.3.4 Wires used for internal connections shall be of a temperature class which corresponds to the maximum temperature within the luminaire.

NOTE – Temperature rise tests should be performed at rated voltage and frequency and maximum lamp rating should not result in temperatures in excess of 5 °C above the limits specified.

9.4 Standard types of lampholders

9.4.1 Lampholders shall be of the types listed in table 6

Table 6 – Standard types of lampholders

Designation	Maximum lamp rating	
	Voltage	Load power/current
1. Lampholders for screw cap lamps:		
E40	250 V	3 000 W / 16 A
E27	250 V	200 W / 4 A
E14	250 V	15 W / 2 A
E10	24 V	
2. Lampholders for bayonet cap lamps:		
B22	250 V	200 W / 4 A
B15d	250 V	15 W / 2 A
5s	55 V	15 W / 2 A
3. Lampholders for tubular fluorescent lamps:		
G13	250 V	80 W
G5	250 V	13 W
4. Lampholders for linear tungsten halogen and metal halide lamps:		
R7s	250 V	1 500 W
Fa4	250 V	2 000 W

NOTE – The designations for item 1 are given according to IEC 60238, for items 2, 3 and 4 according to IEC 60061-2. The voltage and current ratings of item 1 are given according to IEC 60238, the power ratings of item 2, 3 and 4 according to IEC 60061-2.

9.4.2 Lampholders of type E40 shall be provided with effective means for locking the lamp in the holder.

9.5 Exposure to mechanical damage

Luminaires likely to be exposed to more than the ordinary risk of mechanical damage shall be protected against such damage or be of specially robust construction.

9.6 Discharge lamp luminaires operating at voltages below 250 V

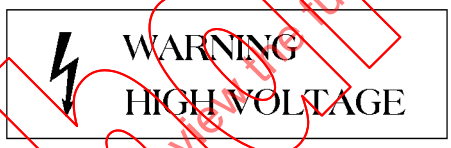
In discharge lamp installations operating at voltages below 250 V, all independent ballasts, capacitors and other auxiliaries mounted separately from the luminaire shall be enclosed in an earthed metal casing.

Every capacitor of 0,5 mF or more shall be provided with means for reducing the voltage of the capacitor to less than 55 V within 1 min after disconnection from the supply source.

9.7 Discharge lamp luminaires operating at voltages above 250 V

9.7.1 General

Discharge lamps operating at voltages above 250 V shall be used only in fixed luminaires. Discharge lamp installations shall, where practicable, be provided with durable and suitable notices bearing the following inscription:



9.7.2 Construction of lamps and lampholders

Caps and lampholders for discharge lamps shall be of robust construction in function of the voltage employed.

9.7.3 Protection of live parts

All live parts of discharge lamp luminaires shall be so designed, placed and installed that they cannot be touched accidentally or inadvertently.

The creepage distance along the surface of the glass tube shall be taken into consideration.

9.7.4 Transformers

Transformers for discharge lamps shall have their primary and secondary windings electrically separated and shall not contain flammable liquid.

Transformers shall be placed within the discharge lamp luminaire or located as closely as possible to the luminaire installation.

9.8 Searchlights and arc lamps

All parts of searchlights or arc lamps to be handled for their operation or adjustment while in use shall be so arranged that there is no risk of shock to the operator.

Disconnection of every searchlight or arc lamp shall be by a multipole (all poles) disconnecting switch.

If a series resistor is used with an arc lamp, the disconnecting switch shall be so placed in the supply circuit that both the series resistor and the arc lamp are disconnected when the switch is in the off position.

9.9 Portable luminaires

9.9.1 Construction

Portable luminaires shall be so constructed and arranged that there is no risk of shock to the operator, in accordance with one of the methods given below:

9.9.2 Supply from an isolating transformer supplying one luminaire only.

9.9.3 Supply at extra low voltage.

9.9.4 Double or reinforced insulation.

9.9.5 Earthing by means of an earth continuity conductor.

9.9.6 Suspension.

Portable luminaires intended to be used on decks, in holds, engine rooms and other similar spaces shall be provided with a hook or ring by which the luminaire can be suspended to avoid stress on the supply cable.

9.10 Marking

Emergency lights shall be marked for easy identification.

10 Heating and cooking appliances

10.1 General

The provisions of this clause are applicable to heating and cooking appliances for use in offshore units.

10.2 General requirements

10.2.1 Heating elements

The heating elements shall be of materials which are resistant to the highest temperature which they attain in normal service and shall be so arranged that they can be readily replaced.

10.2.2 Internal connections

10.2.2.1 Electrical connections between heating elements shall be effected either by joining parts of the elements themselves, or by a construction such that the terminals and the connecting conductor will not deteriorate at the maximum temperature to which they may be subjected.

10.2.2.2 The connections between heating elements and the switches and to the supply cables shall be carried out with the aid of suitable terminals. The connections shall be such that the terminals and switches are not increased in temperature above that for which they are designed. At ambient temperatures that are in accordance with IEC 61892-1[1)] the temperature of the terminals for the supply cables (including the internal earthing) may exceed 75 °C. These terminals shall be clearly labelled.

10.2.2.3 Connections between heating elements and between heating elements and terminals to which insulated cables may be connected, unless they are self-supporting or rigidly fixed in position, shall be continuously insulated with suitable incombustible material.

10.2.2.4 Bare connections shall be made of corrosion-resistant material, shall be suitable for the temperature involved and be self-supporting. Supports of bare connections shall comply with 10.2.3.

10.2.2.5 Ceramic beads shall be used only when the connections are so fixed or supported that they cannot change their position and the beads cannot be damaged in normal use.

10.2.3 Supports of live parts

All live parts subjected to heat, be they heating elements, bare connections or terminals, shall be carried on incombustible material, which is moisture resistant or effectively protected against the penetration of moisture.

10.2.4 Guarding of live parts

Heating elements shall be suitably guarded. The guards shall be of robust construction and so fitted that they cannot be brought into contact with any current-carrying part when in service. The openings of the protecting guard shall be sufficiently narrow to prevent the heating elements from being touched or short-circuited when the standard test finger is applied. Live parts of cooking appliances shall be so protected that the cooking utensils cannot be brought into contact with them. Spilling or overflowing of liquid or food shall not cause short circuits or insulation failures.

---

1) In preparation. Before IEC 61892-1 is published, see IEC 60092-101.

10.2.5 Temperature limits of exposed parts

Electric heating and cooking appliances shall be so constructed that parts which are necessarily handled in use cannot become heated to a temperature exceeding the values given in table 7.

Table 7 – Temperature limits of exposed parts

Handles, grips and the like made of	Maximum temperature during normal use held in the hand °C	
	For long periods	For short periods
Metal	55	60
Porcelain and vitreous material, moulded material, rubber or wood	65	70

For ambient temperature, see IEC 61892-1[1)] .

Higher temperatures may be acceptable for parts which normally will not be handled with unprotected hands, such as handles of drawers for spilled liquid in cooking ranges.

10.2.6 Control of heating and cooking appliances

Control switches, when in the off position, shall isolate the heating elements in all non-earthed poles.

10.2.7 Position of controller

10.2.7.1 The position of fuses, switches and other control elements fitted in or near the appliances shall be such that they will not be subject to temperatures above those for which they are designed and will be accessible for inspection, for example through separate covers.

10.2.7.2 A means by which power to the galley can be cut off in the event of a fire shall be fitted outside the galley exits in positions not likely to be made inaccessible by such a fire.

10.2.8 Earthing

Appliances, whether portable or fixed, shall be provided with suitable terminals for earthing the metallic framework; such terminals shall be effectively connected to earth.

10.2.9 Rating plates

Appliances shall be clearly and indelibly marked at least with the manufacturer's name and address and type designation, rated voltage(s), rated input, and where necessary, with the nature of supply and frequency.

1) In preparation. Before IEC 61892-1 is published, see IEC 60092-101.

10.2.10 Insulation tests

10.2.10.1 Appliances, including their control equipment, shall be tested when cold by the manufacturers, and shall be able to withstand the application of an a.c. voltage of 1 000 V plus twice the rated voltage, with a minimum of 1 500 V at a frequency of 25 Hz to 100 Hz, for 1 min, between all current-carrying parts and the metallic frame.

10.2.10.2 For portable appliances, the leakage current shall not exceed 1 mA, and for stationary appliances 1 mA or 1 mA per kW rated input, whichever is the larger, for each heating element which can be switched off separately.

10.2.11 Excess temperature protection – Thermal cut-outs

10.2.11.1 Heating apparatus is to be provided with a device which will switch off the apparatus before dangerous temperatures occur, unless the apparatus is specially approved without such a device. The cut-out device is to be free-tripping and manual-resetting. When thermostats are provided in addition to the excess temperature protection, these shall operate independently. A fault in one of them or in its supply connection shall not put the other out of operation.

10.2.11.2 Galley equipment, which may give rise to overheating and fire, shall be fitted with thermal protection devices to interrupt the supply in the event of overheating.

10.3 Special requirements for galley appliances

10.3.1 Enclosures of heating and cooking galley appliances

Cooking and heating appliances and their control equipment fitted in galley spaces shall have a degree of protection of at least IP44 according to IEC 60529. Enclosures shall be corrosion-resistant and provided with one or more drainholes.

10.3.2 Electric separation of combined heating and cooking appliances

Combined heating and cooking appliances shall be of such construction that the live parts of the different sections are mechanically separated and that, when replacing components on one section, no live parts of the other section can be touched.

10.3.3 Stability

Portable cooking appliances shall be shape and weight preventing them from being easily overturned.

10.4 Special requirements for space-heating appliances

10.4.1 Types of space-heating appliances

Space heaters shall be of the convector type and of the permanently fixed type; however, heaters with a visible element may be used, provided they are designed and installed in such a manner as to eliminate the risk of fire.

10.4.2 Construction of space-heating appliances

Space heaters shall be durable and all parts shall be of strong construction. All screws and nuts shall be effectively locked.

10.4.3 Shielding

Space heaters shall have an inclined top-plate which fits closely against a bulkhead, or a corresponding shield, and shall be so designed and protected that combustible articles, clothes and similar are prevented from coming into contact. Shields and other protection shall be designed and located so that adjacent bulkheads, etc. are not heated excessively.

11 Trace and surface heating

11.1 General

The provisions of this clause are applicable to electrical trace and surface heating equipment on offshore units.

NOTE 1 – For safety requirements in electroheat installations, see IEC 60519.

NOTE 2 – For installation requirements, see IEC 61892-6.

11.2 Construction

Trace or surface heating systems shall be constructed in accordance with a standard acceptable to the appropriate authority.

11.3 Protection

Trace and surface heating systems shall be supplied from separate circuits, not rated above 63 A.

NOTE – For the self-limiting type, the design must take into account the start up current (cold inrush current) from minimum switch-on temperature.

11.4 Protection against mechanical damage

11.4.1 In situations where the trace heating cable or the surface heating unit is liable to mechanical damage they shall be provided with suitable protection.

11.4.2 Notices are to be provided indicating the location of cables or tapes and warning personnel not to stand on traced pipes, etc.

11.5 Installation in hazardous areas

Trace and surface heating systems intended for hazardous areas shall be in accordance with a standard acceptable to the appropriate authority.

12 Communication

12.1 General

The provisions of this clause are related to:

- equipment for radio communication and navigation either by atmospheric path or via satellite;
- automatic pilots, helm indicators, telegraphs, clocks, etc., where applicable;
- manual and automatic alarms for personnel and public address and/or call systems;
- telephone, telex, telefax and closed-circuit television systems.

12.2 Safety requirements

Electronic equipment shall comply with the safety requirements of IEC 60065 where applicable.

12.3 Other requirements

Equipment shall comply with the performance standards required by the International Convention for the Safety of life at Sea (SOLAS) and the National Authority, when applicable, and shall comply with the requirements of the International Special Committee on Radio Interference (CISPR) with regard to levels of conducted and radiated interference.

12.4 Safety and maintenance

12.4.1 All items of equipment, accessories and cables shall be of robust design and so installed as to insure an ample margin of safety and reliability in operation under both normal and fault conditions.

12.4.2 Equipment which operates under automatic or remote control shall do so without danger to personnel who may be in close proximity.

12.4.3 As a minimum, warning notices shall be provided in equipment areas where there is a danger from shock, radio-frequency burns and other injuries from radiation, including X-rays.

Adequate means of isolation shall be provided, preferably interlocked, to prevent accidental shock or exposure to radiation during maintenance.

12.4.4 Communal antennas for broadcast reception shall have facilities for isolation, muting and/or protection.

12.4.5 Means shall be provided for the discharging to earth of any lightning energy that may be induced in radio and navigational equipment antennas. Consideration shall be given to the installation of transient protective devices such as spark gaps or surge diverters.

12.4.6 Communications equipment required to operate in the event of power failure shall be provided with an alternative power supply independent of the primary supply.

13 Underwater systems and appliances

13.1 General

The provisions of this clause are applicable to electrical installations for use under water, which are connected to or operated from an offshore surface unit.

13.2 Fixed diving systems

Electrical installations for fixed diving systems shall be in accordance with the "Code of Safety for Diving Systems", published by the International Maritime Organization (IMO), London, 1985. Any national requirements shall apply.

NOTE – Design of electrical installations and electrical equipment is normally considered to be in accordance with the above IMO requirements if the design is in accordance with the "Code of Practice for the Safe Use of Electricity Under Water" published by the Association of Offshore Diving Contractors, London, Sept. 1985.

13.3 Temporary diving systems

Electrical installations for temporary systems for use during diving operations, not belonging to the permanent installation as a part of the vessel/offshore unit, shall comply with requirements as stipulated for the permanent installation.

NOTE 1 – Such temporary equipment could be a surface diving station, a Remote Operated Vehicle (ROV), etc.

NOTE 2 – For definitions of the terms "fixed diving systems" and "temporary diving systems", see the Code of Safety for Diving Systems, published by the IMO.

14 Control and instrumentation

14.1 General

The provisions of this clause are applicable to electrical, electronic and programmable equipment intended for control, monitoring, alarm and protection systems for use in offshore units.

NOTE 1 – If control and instrumentation aspects of closures in watertight bulkheads or shell plating, bilge pumping, fire protection, fire extinction, are carried out by electrical methods, attention is drawn to additional requirements in SOLAS, Chapter II-1, Regulations 15, 16, 17, 21 and Chapter II-2.

NOTE 2 – For specific installations, guidance may be found in IEC 60092-504 where applicable.

14.2 General requirements

14.2.1 Operation

Operation of the control equipment shall be simple to perform.

14.2.2 Reliability

Each component or system shall possess a degree of reliability in accordance with the importance of the control system of which it forms part.

14.2.3 Stability

Each automatic control system, together with its controlled process, shall be stable throughout its range of operation.

14.2.4 Repeatability and accuracy

The repeatability and accuracy of instruments and control equipment shall be adequate for their proposed use and shall be maintained at their specified value during their expected lifetime and normal use.

14.2.5 Segregation

Protection (safety) systems shall be, as far as possible, continuously available and fully independent from other control and alarm systems.

14.3 Environmental and supply conditions and testing

14.3.1 General conditions

For general environmental conditions see IEC 61892-1[1)] .

1) In preparation. Before IEC 61892-1 is published, see IEC 60092-101.

For electric and electromagnetic compatibility, see 14.3.5 and 14.3.6.

In view of the special type of components, etc., used in control equipment, some design parameter severities have been established for certain environmental factors and are stated in 14.3.2 to 14.3.5. All control equipment shall operate satisfactorily within the described limits under those environmental conditions.

14.3.2 Ambient air temperatures

For mobile units in general, the high ambient air temperature shall be taken as 55 °C, and the low ambient temperature as +5 °C, except in non-weather-protected locations, for example on open deck, where the low temperature shall be taken as –25 °C.

NOTE – For mobile units which are limited to certain areas of operation where temperature range requirements are less than stated, the above alternative values may be agreed with the appropriate authority.

This range of temperatures may be reduced where equipment is located in a controlled environment provided with an alarm for abnormal conditions and when alternative means are provided to maintain the required environment in the event of a failure of the normal air conditioning.

For fixed units, see IEC 60654-1.

Where extreme ambient temperatures are expected to exist, for example in positions directly adjacent to engines, boilers, etc., or exposed to radiation from the sun, special consideration shall be given. When equipment is located in panels or cubicles, consideration shall be given to the temperature rise inside those panels due to the dissipation of heat from its own components.

14.3.3 Humidity

The relative humidity shall be taken as 95 % at temperatures up to 45 °C, and 70 % at all higher temperatures.

14.3.4 Mechanical conditions

14.3.4.1 Vibration

14.3.4.1.1 General

The stationary sinusoidal vibration shall be taken as having the following parameters and severities:

– displacement amplitude of 1,5 mm in the frequency range 2 Hz to 13 Hz;
– acceleration amplitude of 10 m/s² in the frequency range 13 Hz to 100 Hz.

If the natural frequencies of equipment, suspension and supports, including individual parts, cannot be kept outside the specified range by constructional design methods, vibration shall be damped to a suitable value if malfunction is to be expected.

14.3.4.1.2 Vibration at special locations

At special locations, for example directly on all engines, diesel engine exhaust systems, diesel generator sets, compressors, and in steering-gear rooms, the stationary sinusoidal vibration shall be taken as having the following parameters and severities:

– displacement amplitude of 1,5 mm in the frequency range 2 Hz to 28 Hz;
– acceleration amplitude of 50 m/s² in the frequency range 2 Hz to 200 Hz.