

Mobile and fixed offshore units — Electrical installations —

Part 3: Equipment

ICS 75.180.10

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Summary of pages

This document comprises a front cover, an inside front cover, the IEC title page, pages 2 to 64, an inside back cover and a back cover.

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This British Standard, having been prepared under the direction of the Electrotechnical Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 December 2000

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Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 36759 2

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)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MOBILE AND FIXED OFFSHORE UNITS – ELECTRICAL INSTALLATIONS – Part 3: Equipment

FOREWORD

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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

inverter

converter 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

converter 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 commute.

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 61892-5¹⁾

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 $\pm 2,5$ % of the rated voltage for all loads between zero and rated load at the rated power factor. These limits may be increased to $\pm 3,5$ % 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 61892-2²⁾.

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 61892-2²⁾ 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 61892-5¹⁾.

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.