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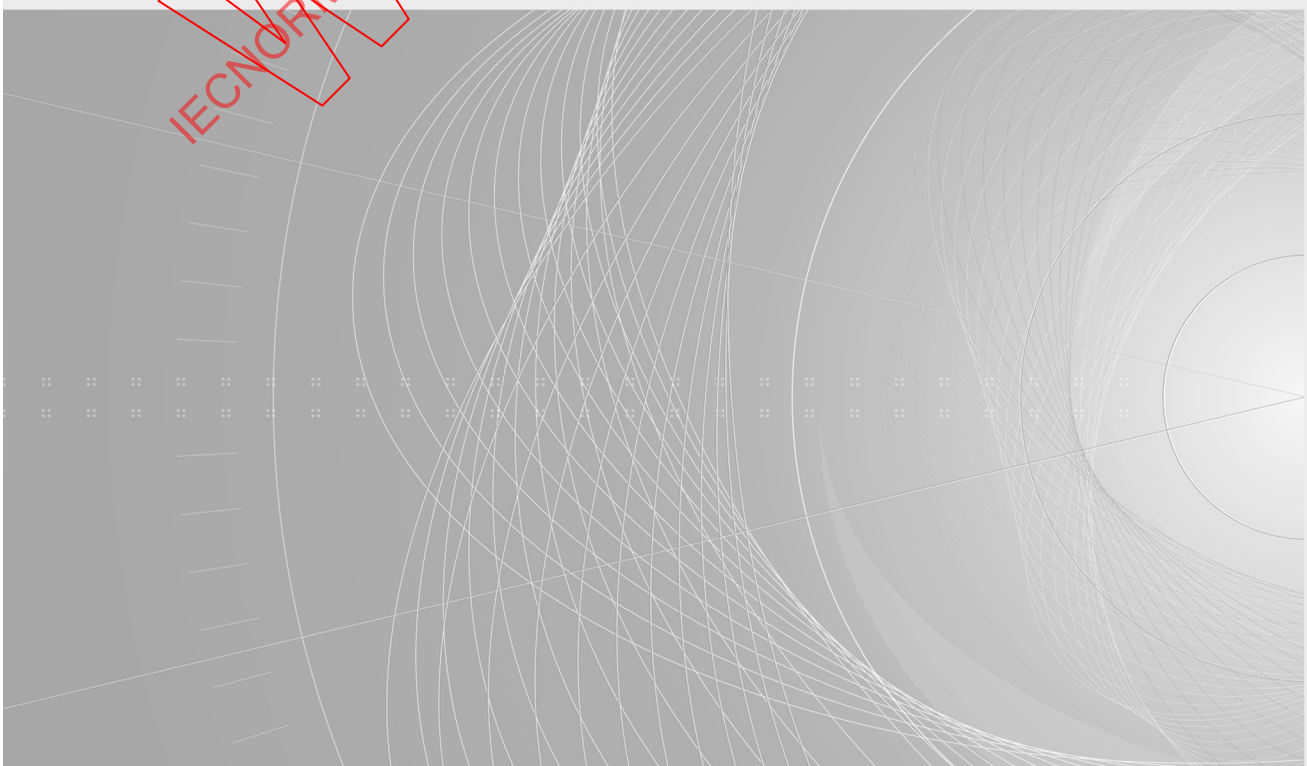
Edition 2.0 2010-08

INTERNATIONAL STANDARD

Mobile and fixed offshore units – Electrical installations – Part 5: Mobile units



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

MOBILE AND FIXED OFFSHORE UNITS – ELECTRICAL INSTALLATIONS –

Part 5: Mobile units

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61892-5 has been prepared by IEC technical committee 18: Electrical installations of ships and of mobile and fixed offshore units.

This second edition cancels and replaces the first edition published in 2000. This edition constitutes a technical revision.

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

a) the requirement to d.c. generators has been deleted;
b) the requirement to EMC has been rewritten;
c) the requirement to power management system has been added;
d) an informative annex regarding testing of DP systems has been added.

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

FDIS	Report on voting
18/1167/FDIS	18/1177/RVD

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

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

The requirements specified in this International Standard are based on the Code for the Construction and Equipment of Mobile Offshore Drilling Units (1989 MODU CODE) published by the International Maritime Organization (IMO), and might include additional provisions.

A list of all the parts in the IEC 61892 series, under the general title *Mobile and fixed offshore units – Electrical installations*, can be found on the IEC website.

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

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

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

INTRODUCTION

IEC 61892 forms 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 used for exploration or exploitation of petroleum resources.

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

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

MOBILE AND FIXED OFFSHORE UNITS – ELECTRICAL INSTALLATIONS –

Part 5: Mobile units

1 Scope

This part of IEC 61892 specifies the characteristics for electrical installations in mobile units, for use during transfer from one location to another and for use during the exploration and exploitation of petroleum resources.

It applies to all installations, whether permanent, temporary, transportable or hand-held, to a.c. installations up to and including 35 000 V and d.c. installations up to and including 1500 V.(a.c. and d.c. voltages are nominal values).

NOTE Attention is drawn to further requirements concerning electrical installations on such mobile offshore units contained in the MODU CODE of the International Maritime Organization (IMO).

2 Normative references

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

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

IEC 60034-6, *Rotating electrical machines – Part 6: Methods of cooling (IC Code)*

IEC 60076 (all parts), *Power transformers*

IEC 60092-501:2007, *Electrical installations in ships – Part 501 Special features – Electric propulsion plant*

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

IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

IEC 60332-3-22, *Tests on electric cables under fire conditions – Part 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category A*

IEC 61000-6-2:2005, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61378-1, *Convertor transformers – Part 1: Transformers for industrial applications*

IEC 61892-1, *Mobile and fixed offshore units – Electrical installations – Part 1: General requirements and conditions*

IEC 61892-2, *Mobile and fixed offshore units – Electrical installations – Part 2: System design*

IEC 61892-3, *Mobile and fixed offshore units – Electrical installations – Part 3: Equipment*

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

IMO-110E, IMO-111F and IMO-113S, *International Convention for the Safety of Life at Sea (SOLAS)*

IMO *Guidelines for vessels with dynamic positioning systems – see IMO/MSC/Circ. 645, Annex, International Maritime Organization*

IMO 904E, *Convention on the International Regulations for Preventing Collisions at Sea, International Maritime Organization (COLREG)*

3 Terms and definitions

For the purposes of this document the terms and definitions given in IEC 61892-1, IEC 61892-2, IEC 61892-3, IEC 61892-6 and the following apply.

3.1
auxiliary steering gear
equipment, other than any part of the main steering gear, necessary to steer the unit in the event of failure of the main steering gear but not including the tiller, quadrant or components serving the same purpose

3.2
dynamic positioning (DP) system
equipment necessary to provide means of controlling the position and heading of a mobile unit within predetermined limits by means of resultant vectored thrust

3.3
electric steering gear
power operated steering gear where an electric motor applies torque to the rudder stock through mechanical means only

3.4
electrohydraulic steering gear
power operated steering gear where a hydraulic pump, driven by an electric motor, applies torque to the rudder stock through hydraulic and mechanical means

3.5
main steering gear
machinery, rudder actuators, steering gear power units and ancillary equipment and the means of applying torque to the rudder stock (for example tiller or quadrant) necessary for effecting movement of the rudder for the purpose of steering the unit under normal service conditions

3.6
petroleum
complex mixture of hydrocarbons that occurs in the earth in liquid or gaseous forms

3.7
propulsion machine (electric)
rotating machine normally intended to provide propulsive power

3.8
redundancy
in an item, the existence of more than one means for performing a required function [IEC 60050-191:1990, 191-15-01]

3.9
semiconductor convertor
an electronic power converter with semiconductor valve devices [IEC 60050-551:1998, 551-12-42]

3.10
steering gear control system
equipment by which orders are transmitted from the navigating bridge to the steering gear power units

NOTE Steering gear control systems comprise transmitters, receivers, hydraulic control pumps and their associated motors, motor controllers, piping and cables, etc.

3.11
steering gear power unit (electric steering gear)
electric motor and its associated electrical equipment used to operate the steering gear

3.12
steering gear power unit (electrohydraulic steering gear)
electric motor and its associated electrical equipment and connected pump used to operate the steering gear

4 General requirements

4.1 Protection against flooding

In every mobile unit in which electric power is used for the services necessary for the safety of the unit, the generators, switchgear, motors and associated controlgear for such services, with the exception of machinery in the platform of semi-submersibles, shall be so situated or arranged that they continue to operate satisfactorily in the event of partial flooding by bilge water above the tank top in the space in which they are situated.

4.2 Rotating machines

Rotating machines shall be installed to minimise the effects of motion. The design of bearings of all machines and the arrangement for their lubrication shall be adequate to withstand the motions encountered in heavy weather and operation for prolonged periods at the list and trim specified in Clause 5 without the spillage of oil.

4.3 Conductors, equipment and apparatus

Conductors, equipment and apparatus shall be placed at such a distance from each magnetic compass or shall be so disposed that the interfering external magnetic field is negligible; that is, the total singular deviation shall not exceed 30 min when any combination of circuits is switched on and off.

4.4 Main switchboards

The main switchboard shall be subdivided into at least two parts. The subdivision may be effected by removable links, circuit-breakers or other suitable means so that the main generators and any supplies to duplicated services which are directly connected to the busbars are, as far as is practicable, equally divided between the sections.

4.5 Precautions against vibration and mechanical shock

Machines, equipment and apparatus shall be unaffected by vibration and shock likely to arise under normal service. Screws and nuts securing current-carrying parts shall be effectively locked so that they cannot work loose by vibration. The locking of screws and nuts securing noncurrent-carrying parts is recommended where necessary.

4.6 Axes of rotation

For units where the requirements to dynamic conditions, as specified in 5.5 apply, horizontal rotation machines shall to the extent possible be installed preferably with the shaft in the fore-and-aft direction. Where a machine is installed athwartship, it shall be ensured that the design of the bearings and the arrangements for lubrication are satisfactory to withstand the rolling specified in Clause 5. The manufacturer shall be informed when a machine for installation athwartship is ordered.

5 Limits of inclination of the unit

5.1 Authority requirement

Dependent upon the outcome of all studies relevant to the intact and damaged stability of the unit, the appropriate authority may require or permit deviations from the angles stated in 5.2, 5.3 and 5.4.

5.2 Machines, equipment and apparatus – General

All machines, equipment and apparatus shall operate satisfactorily under all conditions with the unit upright and when inclined up to the following angles from the normal:

– for column stabilized units, 15° in any direction;
– for self-elevating units, 10° in any direction;
– for surface units, 15° either way in list and simultaneously trimmed 5° by the bow or stern.

5.3 Propulsion machinery

Main propulsion machinery and all auxiliary machinery essential to the propulsion and safety of the mobile unit shall be capable of operating under the static conditions specified in 5.2 and the following dynamic conditions:

– for column stabilized units, 22° 30′ in any direction;
– for self-elevating units, 15° in any direction;
– for surface units, 22° 30′ rolling and simultaneously pitching 7° 30′ by the bow or stern.

5.4 Emergency machinery

Emergency machines, equipment and apparatus fitted in accordance with requirements from the appropriate authority for emergency plant shall operate satisfactorily under all conditions with the unit upright and when inclined up to the following maximum angles from the normal:

– for column stabilized units, 25° in any direction;
– for self-elevating units, 15° in any direction;
– for surface units, 22° 30′ about the longitudinal axis and/or when inclined 10° about the transverse axis.

5.5 Dynamic condition

Where required by the appropriate authority, dynamic condition limits shall apply as follows:

– rotation about fore-and-aft axis (rolling), ±22° 30′ ;

– rotation about athwartship (pitching), ±7° 30′ .

NOTE These motions may occur simultaneously.

6 Bilge pumps

6.1 Power supply

Motors of permanently installed emergency bilge pumps, if any, shall be connected to an emergency switchboard.

6.2 Cables and cable connections

Cables and their connections to submersible pumps shall be capable of operating under a head of water equal to their distance below the worst damaged condition waterline. The cables shall either be armoured or mechanically protected by other means and shall not be installed within the assumed extent of damage. They shall be installed in continuous lengths from above the worst damaged condition waterline to the motor terminals, entering the air-bell from its underside.

6.3 Location of starting arrangement

Under all circumstances it shall be possible to start the motor of a permanently installed bilge pump from a convenient point above the worst damaged condition waterline and in a space not within the assumed extent of damage.

NOTE Information regarding the worst damaged condition waterline and the spaces within the assumed extent of damage is given in IMO requirements.

7 Navigation lights

7.1 General

Except when a unit is stationary and engaged in operations, attention is drawn to IMO 904E.

7.2 Navigation lights when in operation

When a unit is stationary and engaged in operations, attention is drawn to the requirements for the safety of navigation of the coastal state in whose territorial sea or on whose continental shelf the unit is operating.

NOTE Unless otherwise required for the obstruction lighting by national authorities, the lighting is to be in accordance with the requirements of IALA.

7.3 Steaming lights

All units shall be provided with "steaming lights" which comprise masthead, side, stern, anchor, not-under-command and, if applicable, special-purpose lights. The construction and installation of navigation lights shall be to the satisfaction of the appropriate authority.

7.4 Collision regulations

Attention is drawn to the Collision Regulations in relation to the provision of primary and alternative lanterns for each of the navigation lights.

7.5 Power supply and monitoring systems

The following electrical arrangements relate only to the navigation lights referred to in 7.3 and 7.4.

– Each light shall be connected by a separate cable to a distribution board reserved solely for navigation lights, fitted in an accessible place under the control of watchkeeping personnel.

– There shall be two separate power supply systems to the distribution board, one being from the main switchboard and one from the emergency switchboard. Where a transitional source of emergency power is required by the Safety of Life at Sea (SOLAS) Convention, the arrangements shall enable the lights to be supplied from this source in addition to the emergency switchboard. An alarm shall be activated in the event of failure of a power supply to the distribution board.

– As far as practicable, the arrangements should be such that a fire, a fault or mechanical damage at any one point will not render both systems inoperative. It is, however, accepted that the systems must come together at some point where the changeover can be performed. This should, preferably, be at or near to the distribution board.

– Each light shall be controlled and protected in each insulated pole by a switch and fuse or by a circuit-breaker mounted in the distribution board.

– Each light shall be provided with an automatic indicator to give an acoustic and/or optical alarm in the event of complete extinction of the light. If an optical signal is used, which is connected in series with the steaming light, means to prevent failure of the indicator extinguishing the steaming light shall be provided. If an acoustic device alone is used it shall be connected to an independent source of supply, for example a battery, and provision shall be made for testing this supply.

NOTE The use of junction boxes in navigation light circuits, other than those provided for connecting the lanterns to the fixed wiring of the electrical installation, should be avoided. Cables for different circuits should not use the same junction box.

7.6 Special requirements for lights using LEDs

The luminous intensity of LEDs gradually decreases while the electricity consumption remains unchanged. The rate of decrease of luminous intensity depends on the output of LEDs and temperatures of LEDs. To prevent shortage of luminous intensity of LEDs one of the following solutions shall be used:

- An alarm function shall be activated to notify the Officer of the Watch that the luminous intensity of the light reduces below the level required by COLREGs; or
- LEDs shall only be used within the lifespan (practical term of validity) specified by the manufacturer to maintain the necessary luminous intensity of LEDs. The lifespan of LEDs should be determined and clearly notified by the manufacturer based on the appropriate test results on the decrease of luminous intensity of the LEDs under various temperature conditions and on the temperature condition of LEDs in the light during operation, taking the appropriate margin into account.

NOTE The manufacturer of the navigation light should give information regarding detection of low illumination intensity.

8 Steering gear

8.1 Power operated steering gear

8.1.1 Electric and/or electrohydraulic steering gear shall be used for the power-operated main and auxiliary steering gear required by the appropriate authorities.

8.1.2 The electrical systems of the main steering gear and auxiliary steering gear shall be so arranged that any failure in one of the steering gears will not render inoperative the electrical systems of the other steering gear.

When an auxiliary steering gear is not required by the appropriate authorities and the main steering gear comprises two or more power units, the electrical system for each power unit shall be so arranged that the failure of one of them will not render the other units inoperative.

8.2 Motors

8.2.1 To determine the required characteristics of the electric motors for power units, the breakaway torque and maximum working torque of the steering gear under all operating conditions shall be used. The ratio of pull-out torque to rated torque shall be at least 1,6.

8.2.2 The rating shall be determined on the basis of the steering gear characteristics of the subject unit as specified in 8.2.2.1 and 8.2.2.2.

NOTE Motors for steering gear power units may be rated for intermittent power demand.

8.2.2.1 For motors of electric steering gear power units the rating shall be as follows:

S3 – 40 % in accordance with IEC 60034-1.

8.2.2.2 For motors of electrohydraulic steering gear power units and for convertors, the rating shall be as follows:

S6 – 25 % in accordance with IEC 60034-1.

8.3 Motor starters

Each electric motor of a main or auxiliary steering gear power unit shall be provided with its own separate motor starter gear, either located within the steering gear compartment or in the supply switchboard rooms (see 8.1.2).

8.4 Power circuits supply

8.4.1 Each electric or electrohydraulic steering gear comprising one or more power units should, except as otherwise permitted by the appropriate authorities, be served by at least two exclusive circuits, one fed directly from the main switchboard and one of the circuits shall be supplied through the emergency switchboard.

NOTE 1 An auxiliary electric or electrohydraulic steering gear associated with a main electric or electrohydraulic steering gear may be connected to one of the circuits supplying the main steering gear.

NOTE 2 The power supply system should be an IT system. For further information regarding IT systems, see 61892-2.

8.4.2 The circuits supplying an electric or electrohydraulic steering gear shall have a continuous rating for supplying all electric motors and devices which can be simultaneously connected to them and may be required to operate simultaneously.

8.4.3 For certain units specified by the appropriate authorities, an alternative power supply from the emergency source of electrical power or from an independent source of power located within the steering gear compartment, is required.

This power supply shall be activated automatically, within 45 s, in the event of power failure of the main source(s) of electrical power and shall meet the requirements of the appropriate authorities.

8.5 Supply of control circuits and control systems

8.5.1 Each control for starting and stopping of motors for power units shall be served by its own control circuit supplied from its respective power circuit.

8.5.2 Any electrical main and auxiliary steering gear control system shall be served by its own separate circuit supplied from a steering gear power circuit from a point within the steering gear compartment, or directly from switchboard busbars supplying that steering gear power circuit at a point on the switchboard adjacent to the supply to the steering gear power circuit.

8.6 Circuit protection

8.6.1 Short-circuit protection shall be provided for each control circuit and each power circuit of electric or electrohydraulic main and auxiliary steering gear.

8.6.2 No protection other than short-circuit protection shall be provided for steering gear control system supply circuits.

8.6.3 Protection against excess current, if provided for power circuits, shall be for not less than twice the full load current of the motor or circuit so protected, and shall be arranged to permit the passage of the appropriate starting currents.

8.7 Starting and stopping of motors for steering gear power units

8.7.1 Motors for power units shall be capable of being started and stopped from a position on the navigating bridge and from a point within the steering gear compartment.

Means shall be provided at the position of the motor starters for isolating any remote controlled starting and stopping devices.

8.7.2 Main and auxiliary steering gear power units shall be arranged to restart automatically when power is restored after a power failure.

8.8 Steering gear control systems

8.8.1 For the main steering gear, control for the steering gear shall be provided both on the navigating bridge and in the steering gear compartment.

8.8.2 For the power operated auxiliary steering gear, control for steering gear shall be provided in the steering gear compartment and it shall also be operable from the navigating bridge and shall be independent of the control system for the main steering gear.

8.8.3 When, in accordance with the appropriate authorities, an auxiliary steering gear is not installed and the main steering gear comprises two or more identical power units, two independent control systems shall be provided, both operable from the navigating bridge and the steering gear compartment.

NOTE This does not require duplication of the steering wheel or steering lever.

Where the control system includes a hydraulic telemotor, a second independent control system need not be fitted, except where specified by the appropriate authorities.

8.8.4 The steering gear control system provided in accordance with 8.8.1, 8.8.2 and 8.8.3 shall be capable of being brought into operation from a position on the navigating bridge.

8.8.5 Means shall be provided in the steering gear compartment for isolating any steering gear control system operable from the navigating bridge from the steering gear it serves.

8.9 Alarms and indications

8.9.1 Means for indicating that the motors of electric and electrohydraulic steering gear are running shall be installed on the navigating bridge and at a suitable main machinery control position.

8.9.2 Overload alarms shall be provided for motors of power units for all main and auxiliary steering gear.

8.9.3 Where a three-phase power supply is used, an alarm shall be provided that will indicate failure of any one of the supply phases.

8.9.4 In the event of a power failure to any one of the steering gear power units, an alarm shall be given.

8.9.5 In the event of a power failure of electrical power supply to the control system, an alarm shall be given.

8.9.6 A low level alarm for each hydraulic fluid reservoir shall be provided to give the earliest practicable indication of hydraulic fluid leakage.

8.9.7 The alarms specified in 8.9.2 to 8.9.6 shall be both audible and visual and should be located as indicated in 8.9.1 and as specified by the appropriate authorities.

8.10 Rudder angle indication

The angular position of the rudder shall be indicated on the navigating bridge. The rudder angle indication system shall be independent of the steering gear power and control systems and be supplied either through the emergency switchboard or by an alternative independent source of electric power.

NOTE The angular position of the rudder should be recognizable, in accordance with the appropriate authorities, in the steering gear compartment. The indication need not be electrical.

8.11 Separation of circuits

Duplicated electric power circuits and their steering gear control systems with their associated components should be separated as far as practicable.

The corresponding cables should follow different routes, which should be separated both vertically and horizontally, as far as practicable, throughout their entire length.

8.12 Communication between navigating bridge and steering gear compartment

A means of communication shall be provided between the navigating bridge and the steering gear compartment.

If electrical, it shall be fed through the emergency switchboard; if not, it shall be sound-powered.

9 Electric propulsion

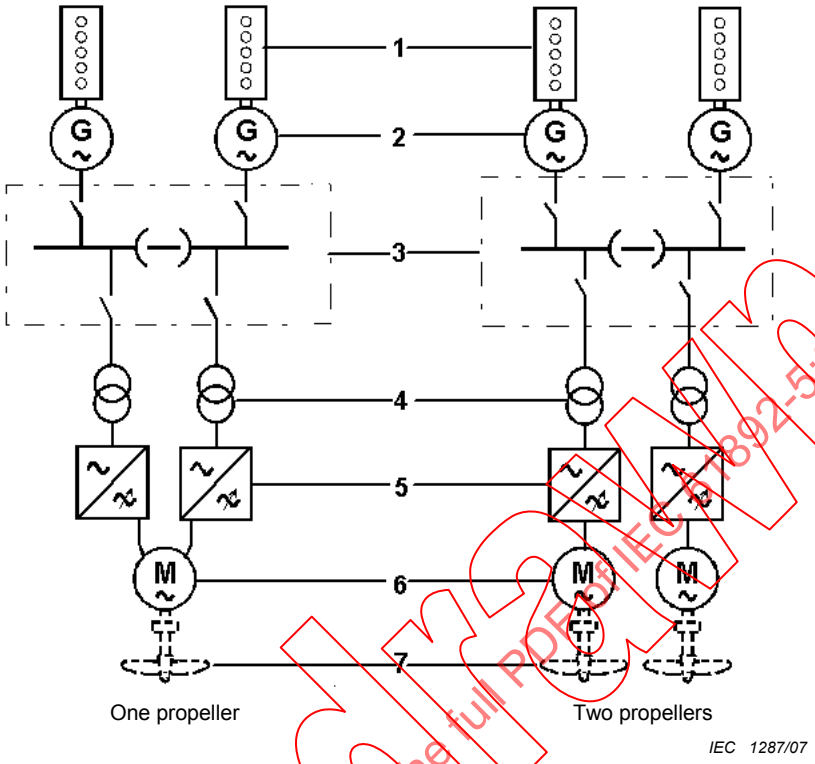
9.1 General

A typical electrical propulsion system consists of the following hardware components:

- propulsion generators;
- switchboard;
- transformers to convert the ships voltage to the convertor voltage;
- convertor to supply the electric motor;
- control system;

- propulsion motor.

A typical configuration of the hardware components is shown in Figure 1.



Key

1 Main engine
2 Propulsion generator
3 Switchboard
4 Propulsion transformer
5 Propulsion convertor
6 Propulsion motor
7 Propeller

Figure 1 – Typical equipment (configuration) for unit with one or two propellers

NOTE 1 Requirements applicable to propulsion systems may also be applicable to other consumers directly connected to the main electric propulsion system, the functioning of which may influence the propulsion or manoeuvrability of the unit.

NOTE 2 For semiconductor convertors, reference is made to IEC 61892-3 and IEC 61892-6.

9.2 General requirements

9.2.1 Torque and critical speeds

9.2.1.1 The normal torque available in the propulsion motors for manoeuvring shall be such as to enable the unit to be stopped or reversed, when the unit is travelling at its maximum service speed, in a time to be agreed between the builder and the manufacturers of the electrical propulsion equipment. This time shall be based on the estimated torque-speed characteristics of the propeller during manoeuvring and on other necessary characteristics supplied to the manufacturers of the electrical systems.

NOTE 1 This subclause contains requirements that have to be agreed between manufacturer and purchaser.

NOTE 2 In case of abrupt stop (crash stop), control strategy for azimuth, fixed pitch and controllable pitch will vary and will be subject for agreement.

9.2.1.2 Adequate torque margin shall be provided in a.c. propulsion systems to guard against the motor pulling out of synchronism during rough weather, and on a multiple screw unit when turning, based on the information provided regarding propeller and unit characteristics.

9.2.1.3 In order to prevent excessive torsional stresses and torsional vibrations of excessive magnitude, careful consideration shall be given to co-ordination of the mass constants and the elasticity constants of the entire propulsion system, and electrical characteristics in the system.

9.2.1.4 The entire system, *inter alia*, includes prime movers, generators, convertors, exciters, motors, slip couplings, gearing, shafting and propeller.

9.2.1.5 The electrical system shall be stable under all operating conditions, due regard being paid to switching transients, system recovery after fault and/or maloperation. Operation of the protection equipment shall also be reviewed under these conditions.

NOTE 1 Where generating sets also supply power to services other than propulsion, consideration should be given to the starting requirements of a.c. propulsion machines, such that this should be achieved within the limits of voltage and frequency transient values.

NOTE 2 Where generating sets also supply power to services other than propulsion, consideration should be paid to the priority of the consumers. Power management systems should be taken into consideration.

9.2.2 Lubrication

The lubrication of the bearings of propulsion motors, gearing and shafting shall be effective at all normal speeds from creep speeds upwards either ahead or astern.

The shafts and bearings shall not be damaged by slow rotation, whether or not electrical power is applied to the motor or whether or not such rotation is induced by the propeller, and under all predictable oil temperature conditions.

NOTE Where propeller motors can generate voltage due to rotation induced by the propeller, measures should be taken to avoid disturbances or damage of components and systems.

9.2.3 Prime movers

9.2.3.1 Prime movers of any type shall be provided with a governor capable of maintaining the pre-set steady speed within a range not exceeding 5 % of the rated full-load speed for load changes from full-load to no-load.

Where the speed control of the propeller requires speed variation of the prime mover, the governor shall be provided with means for local manual control as well as for remote control.

In case of parallel operation of generators, the governing system shall permit stable operation to be maintained over the entire operational speed range of the prime movers.

9.2.3.2 The prime mover rated power in conjunction with its overloading and load build-up capabilities shall supply the power needed during transitional changes in operating conditions of the electrical equipment due to manoeuvring and sea and weather conditions.

NOTE With respect to the above, special attention should be paid to diesel engines equipped with an exhaust gas-driven turbine blower for supercharging.

9.2.3.3 When manoeuvring from full propeller speed ahead to full propeller speed astern with the unit making full way ahead, the prime mover shall be capable of absorbing a portion of the regenerated power without tripping due to overspeed.

The setting of the overspeed trip device shall be in accordance with the requirements of the appropriate authority and the amount of the regenerated power to be absorbed agreed to by the electrical and mechanical machinery manufacturers.

Means external to the mechanical and electrical rotating machinery should be provided in the form of phantom or dynamic braking resistors, or ballast consumers to absorb excess amounts of regenerated energy and to retard the speed of rotation of the propulsion motor.

NOTE 1 Alternatively, the amount of regenerated power may be limited by the action of the control system.

NOTE 2 This subclause contains requirements that have to be agreed between manufacturer and purchaser.

NOTE 3 Consideration should be given to absorbing and reusing the braking power in the ship's network.

9.3 Electromagnetic compatibility (EMC) and harmonic distortion

9.3.1 General

Propulsion systems shall comply with performance criterion A of IEC 61000-6-2. This means no degradation of performance or loss of function is allowed during normal operation.

9.3.2 Total harmonic distortion, THD

Equipment producing transient voltage, frequency and current variations is not to cause malfunction of other equipment on board, neither by conduction, induction or radiation.

The design shall take in account that propulsion convertors create interferences within the propulsion network.

For separated propulsion network, the total harmonic distortion (THD) value of the voltage shall not exceed 10 %. All network connected equipment shall be designed to withstand this high level of THD or necessary filters shall be added. If the propulsion network and the unit's network are directly connected, the THD value of the voltage shall not exceed the values stated in IEC 61892-1.

The design of cabling and cables, transformers, protection devices etc. shall take into account the high level of harmonic currents caused by the convertor system.

9.3.3 Radio frequency interference

If convertors for propulsion plants are placed in separate rooms or cabinets, the maximum values for emissions are valid only outside these rooms or cabinets. The immunity requirements of the propulsion convertor shall comply with at least the requirements for all other equipment on board.

Conducted and radiated emissions leaving the convertor cabinet or room shall be reduced to a system-compatible level.

9.4 Harmonic filtering

Line filters can be used to ensure the required harmonic distortion in the mains at any step of propulsion.

Each individual filter circuit shall be protected against overcurrents and short-circuit currents. The fuses in filter circuits shall be monitored.

Using line filters, the filter layout shall be designed for any conceivable line configuration. In particular, self-resonance shall be excluded under any load condition and all generator combinations.

In the case of several parallel filter circuits, the current symmetry shall be monitored. An asymmetrical current distribution in the individual filter circuits and the failure of one filter shall be alarmed.

The additional heating caused by total harmonic distortion shall be taken into account during the temperature rise test.

9.5 Generators, motors, semiconductor convertors and electric slip-couplings

9.5.1 Machine and equipment temperature and ventilation

9.5.1.1 When generators, motors or slip-couplings are fitted with an integral fan (see IEC 60034-6) and are operated at speeds below the rated speed with full-load torque, full-load current, full-load excitation, etc., temperature limits in accordance with IEC 60034-1 shall not be exceeded.

9.5.1.2 The temperature of the cooling air of machines provided with forced air ventilation, air ducts or air filters shall be continuously monitored by means of direct reading thermometers which are readable from outside the machine and by a remote audible alarm actuated by suitable temperature detectors.

For machines with a closed circuit cooling method with a heat exchanger, the flow of primary and secondary coolants shall be monitored.

Consideration shall be given to the necessity of providing equipment for detecting leakage of cooling liquid in a machine enclosure and operating an associated alarm.

NOTE Alternatively, monitoring of the winding temperature plus alarm may be accepted in lieu of flow alarm.

9.5.1.3 Generators operating with semiconductor convertors shall be designed for the expected harmonics of the system. A sufficient reserve shall be considered for the temperature rise, compared with sinusoidal load.

If semiconductor convertors are fitted with forced-ventilation, monitoring means for the cooling system shall be provided.

In case of failure of the cooling system, an alarm shall be given and the current shall be reduced automatically. The alarm signal can be generated by the flow of the coolant, by the electrical supply to the ventilator or by the temperature of the electronic valves.

NOTE 1 Override of the automatic reduction, if necessary, can be considered.

NOTE 2 The normal procedure upon automatic reduction of power will be to reduce power to the drilling system and give full priority to power to the DP system, in order to avoid a drift off, which may cause a blow-out in worst case.

9.5.1.4 Stator windings of a.c. machines and interpole windings of d.c. machines, rated above 500 kW, shall be provided with temperature sensors.

9.5.2 Accessibility and facilities for repair *in situ*

9.5.2.1 For the purposes of inspection and repair, provision shall be made for access to the stator and rotor coils and for the withdrawal and replacement of field coils.

9.5.2.2 Facilities shall be provided for supporting the shaft to permit inspection and withdrawal of bearings.

9.5.2.3 Adequate access shall be provided to permit the resurfacing of commutators and slip-rings, as well as the renewal and bedding of brushes.

9.5.2.4 Slip-couplings shall be designed to permit removal as a unit without axial displacement of the driving and driven shaft, and without removing the poles.

9.5.2.5 Convertors shall be easily accessible and arranged for quick repair and exchange of components.

9.5.3 Protection against moisture and condensate

Effective means shall be provided in propulsion machines and convertors to prevent accumulation of moisture and condensate, even if they are idle for appreciable periods (for example by means of space heaters).

9.5.4 Sudden short circuits

AC machines shall be capable of withstanding a short circuit at their terminals under rated conditions without suffering damage.

9.5.5 Overspeed of propulsion motors

The rotor of propulsion motors shall be capable of withstanding overspeeding up to the limit reached in accordance with the characteristics of the overspeed protection device at its normal operational setting.

9.5.6 Exciter sets

The obtainable current and voltage of exciters and their supply shall be suitable for the output required during manoeuvring and overcurrent conditions including short circuit.

For this reason, attention shall be paid to the strength of shafts and couplings of rotating sets and the power of their driving machines.

9.5.7 Semiconductor convertor design data

9.5.7.1 The following limiting repetitive peak voltages shall be used as a base for the semiconductor valve:

– when connected to a supply specifically for propeller drives, U_{RM} = 1,5 U_P;

– when connected to a common main supply, U_{RM} = 1,8 U_P.

(U_P is the peak value of the rated voltage at the input of the semiconductor convertor.)

If the semiconductors are connected in series, the value mentioned above shall be increased by 10 %. Equal voltage distribution shall be ensured.

9.5.7.2 When semiconductor convertors are used, means shall be taken, where necessary, to limit the effect of disturbances, both to the system and to other semiconductor convertors. The following are examples of items that should be considered in relation to limiting the effect of disturbances:

– convertors when connected to the same busbar system;

– commutation reactance which, if insufficient, may result in voltage distortion adversely affecting other consumers on the system;

– the relation between the system subtransient reactance and the convertor;

– commutation reactance: unsuitable matching may result in the production of voltage harmonics which could cause overheating of other consumers;

– any adverse effect of convertors on the commutation of d.c. machines;

– any adverse effect, in the regenerating mode, if voltage drops on inverter operation;

– interference from high frequency noise.

When filter circuits and capacitors are used for reactive current compensation, the following items should be considered:

– any adverse effect of frequency variation on the r.m.s. and peak values of the system voltage;

– any adverse effect on the voltage regulation of generators.

9.5.7.3 The following protection of convertors shall be provided:

– overvoltage in a supply system to which convertors are connected shall be limited by suitable devices to prevent damage. Protective fuses for these devices shall be monitored. A suitable control shall ensure that the permissible current of semiconductor elements cannot be exceeded during normal operation;

– short circuit currents shall be limited by specially adapted fuses or by other protective means suitable for safe disconnect of convertor. These semiconductor protective fuses shall be monitored. In case of fuse operation, the respective part of the plant shall be taken out of operation;

– fuses in filter circuits shall be monitored.

NOTE Consideration should be given to include excessive current ripple in the scheme of protection.

9.6 Protection against moisture and condensation

Effective means, for example space heaters or air dryers, shall be provided in motors, generators, convertors, transformers and switchboards to prevent accumulation of moisture and condensate, even if they are idle for appreciable periods. Propulsion motors shall be equipped with an electric heating designed to maintain the temperature inside the machine at about 3 K above ambient temperature.

9.7 Controlgear

9.7.1 Location of manoeuvring controls

The main propulsion manoeuvring controls shall be located at a convenient place.

Whenever control outside the engine room is applied, an arrangement shall be provided whereby the propulsion plant can also be controlled from the engine room, or control room.

NOTE In systems equipped with variable pitch propellers, pitch indication should be integrated in the main control station.

9.7.2 Engine order systems

Engine order systems shall be provided on self-propelled units.

NOTE Engine order telegraph systems or other means of engine order systems in accordance with the appropriate authorities can be considered.

9.7.3 Operation of manoeuvring controls

Either manual operation or operation with the aid of power or a combination of both shall be used.

In the case of manual operation, all manoeuvring switches, field-regulators and controllers shall be operable without undue effort.

If failure of power supply occurs in systems with power-aided control (e.g. with electric, pneumatic or hydraulic aid), it shall be possible to restore control in a short time.

NOTE Where it is not possible to revert to full manual control in emergencies, consideration should be given to providing redundancy in equipment to enable a sufficient degree of control to be applied to ensure safety of the installation.

When two or more control stations are provided outside the engine room, a selector switch or other means shall be provided for transferring the manoeuvring controls to the designated station.

Indication of which control station is in command shall be provided at the selector switch and at each control station. Simultaneous control from more than one control station shall not be possible.

Except for systems in which the control levers are electrically or mechanically interconnected in such a manner that each lever will be set to the same position, the changing of the control station shall be possible only when the control levers of the station in command and the incoming station are in the same position or when an acceptance signal set by the desired station is received. The control equipment shall be so arranged that in case of damage to the equipment outside the engine room, control can always be executed from the engine room or the engine control room manoeuvring control stations.

NOTE It is recommended that failure of power aid, when used, shall if possible not result in an interruption of the power to the propulsion shaft, but be indicated by an alarm.

In systems where remote control of the propeller(s) is by control of the prime mover speed or propeller pitch, control is also to be provided for use in emergencies.

9.7.4 Interlocking of the means of control

All control means for operating prime movers, set-up switches, contactors, field switches, etc., shall be interlocked to prevent their incorrect operation.

Access doors for switchgear and controlgear shall be locked to prevent access while equipment is energised, and shall be provided with a key available only to competent personnel.

9.8 Cables and wiring

9.8.1 Conductors

The conductors of cables external to the components of the propulsion plant, other than cables and interconnecting wiring for computers, data loggers or other automation equipment requiring currents of very small value, shall consist of not less than seven strands and have a cross-sectional area of not less than 1 mm^2.

9.8.2 Internal wiring

Internal wiring in main control gear, including switchboard wiring, shall be of flame retardant quality in accordance with IEC 60332-1-2 and 60332-3-22.

NOTE Consideration is to be given to the use of halogen free material making reference for example to IEC 61892-4.

9.8.3 Bus-bars

Bus-bar systems for power transport shall be either certified for lifelong operation without service, or all joints shall be accessible for inspection and maintenance.

9.9 Main and control circuits

9.9.1 Control

Computer based systems shall be designed and tested in accordance with IEC 60092-504.

9.9.2 Power management system

Additional to the requirements described in IEC 60092-504, the following requirements shall apply:

For power supply with generators operating in parallel, there shall be a device/computer program for automatic power management, which will ensure adequate power generation, even in transit/manoeuvre. Automatic load based disconnection of diesel generators in manoeuvre mode is forbidden.

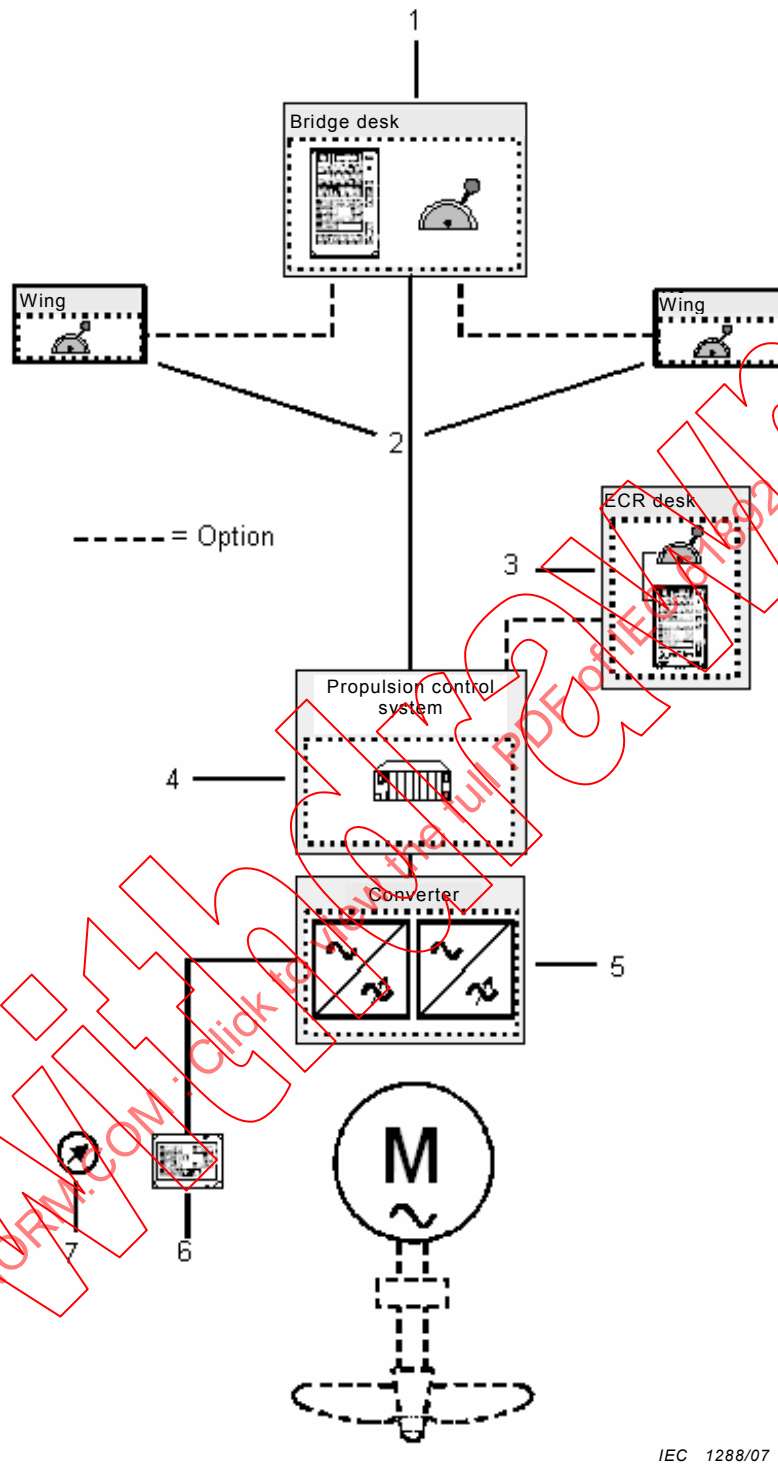
In case of under-frequency of the supplying mains, overcurrent, overload or reverse power of the propulsion generators or overcurrent of large feeders, the power management system shall take necessary actions to ensure power to the propulsion system.

If generators are running in parallel and one of them is tripping, the power supply system shall be provided with suitable means of load reductions to protect the remaining generators against unacceptable load steps. The same requirement applies to bus tie breakers.

Although tripping of the bus tie breaker might not lead to any malfunction of the system, it is not necessary that the system remains in the automatic mode if the supply system is split.

Any loss of automatic function shall be alarmed.

See Figure 2.



Key

1 Bridge desk
2 Wing
3 Engine control room (ECR) desk
4 Propulsion control system
5 Convertors
6 Local control panel
7 Telegraph receiver

Figure 2 – Typical control configuration

9.9.3 Circuitry and components

9.9.3.1 Systems having two or more propulsion generators, two or more semiconductor convertors or two or more motors on one propeller shaft shall be so arranged that any unit can be taken out of service and disconnected electrically.

9.9.3.2 If a propulsion system contains only one generator and one motor and cannot be connected to another propulsion system, more than one exciter set should be provided for each machine. However, this is not necessary for self-excited generators or for multi-propeller propulsion units where any additional exciter set can be common for the unit.

9.9.3.3 Every exciter set shall be supplied by a separate feeder.

9.9.3.4 Field circuits shall be provided with means for suppressing voltage rise when a field switch is opened.

9.9.3.5 If a service generator is also used for propulsion purposes, other than for boosting the propulsion power, the components then being part of the propulsion circuit shall conform to the requirements of this standard.

9.9.3.6 In regulation systems with feedback control, special consideration shall be given to ensure a high degree of reliability.

9.9.3.7 The design of the circuitry and components shall be such that failure of a control signal shall not cause an excessive increase in propeller speed.

The reference value transmitter in the control equipment shall be so designed that any defect in the desired value transmitters or in the cables between the control station and the propulsion system shall not cause a substantial increase in the propeller speed.

9.9.3.8 It shall only be possible to start the engines when the control lever is in zero position and the plant is ready for operation.

NOTE Changing of manoeuvring responsibility should be possible without substantial change in propeller speed or direction or pitch as appropriate.

9.9.3.9 Each control station shall have an emergency stop device which is independent of the control lever.

9.10 Protection of the system

9.10.1 Protection

9.10.1.1 Overcurrent protection devices, if any, in the main circuits shall be set sufficiently high so that there is no possibility of their operating due to the overcurrent caused by manoeuvring or normal operation in heavy seas or in floating broken ice.

9.10.1.2 In excitation circuits, no overload protection shall cause the opening of the circuit.

9.10.1.3 Means shall be provided for selective tripping or rapid reduction of the magnetic fluxes of the generators and motors to ensure that overcurrents do not reach values which may endanger the plant.

9.10.1.4 Means for earth leakage detection shall be provided for main propulsion circuits, and shall be arranged to operate an alarm upon the occurrence of an earth fault. When the fault current flowing is liable to cause damage, tripping arrangements shall be provided.

NOTE Means should be provided for earth leakage detection in the excitation circuits of propulsion machines but may be omitted in circuits of brushless excitation systems and of machines rated up to 500 kW.

9.10.1.5 Semiconductor elements in semiconductor convertors shall have fuse protection or be suitably protected by other means.

9.10.1.6 If there is a possibility of blocking the propeller (for example during ice-breaking conditions) a protection against damage of the propulsion plant shall be provided.

9.10.2 Instrumentation

9.10.2.1 General

At least the following instruments, in addition to those required in IEC 61892-3, shall be provided and mounted in the main control assembly or any other suitable location.

NOTE1 Attention should be paid to the effect of regenerated power on wattmeters and ammeters as the value may exceed those assumed in IEC 61892-3.

NOTE 2 Consideration should be given to providing local indication of bearing temperature where machines have oil lubrication.

NOTE 3 For proposal for alarm matrix, see IEC 60092-501, Annex A.

9.10.2.2 AC propulsion systems

For each propulsion generator the following instrumentation shall be provided:

– ammeter for measuring each phase;
– voltmeter for measuring each phase;
– three-phase wattmeter;
– tachometer or frequency meter.

NOTE 1 When the rated power of semiconductors is a substantial part of the rated power of the generators, the voltmeters of the generator(s) should display the arithmetical mean value of the voltage.

NOTE 2 Alternatively for multi-generator systems, switched voltmeters and frequency meters may be used. A power factor meter or a kilovarmeter or a field ammeter will also be required if generators are to be operated in parallel.

For propulsion generators rated above 500 kW the following instrumentation shall be provided:

– a temperature indicator for reading directly the temperature of the stator windings.

For propulsion motors fed from the main electrical system the following instrumentation shall be provided:

– an ammeter for the main current of each motor and an ammeter for the field current of each synchronous motor.

For propulsion motors rated above 500 kW the following instrumentation shall be provided:

– a temperature indicator for reading directly the temperature of the motor windings.

For each propeller shaft the following instrumentation shall be provided:

– a speed indicator.

For convertors applying parallel connection of bridges of semiconductors, an ammeter may be used for each bridge of semiconductors. This will normally have to be agreed between the manufacturer and user.

9.10.2.3 When two or more control stations are provided for variable speed propellers, a propeller speed indicator shall be provided at each control station.

9.10.2.4 Where control outside the engine room is used, instruments giving the necessary information on the main electric propulsion system shall be installed at the convenient location near such a station.

9.10.2.5 The control station of the propulsion system shall have at least the following indications for each propeller:

ready for operation – power circuits and necessary auxiliaries are in operation;

faulty – propeller is not controllable;

power limitation – in case of disturbance, for example in the ventilators for propulsion motors, in the convertors, cooling water supply or load limitation of the generators.

NOTE See also 9.2.

9.11 Propulsion transformers

Transformers and reactors shall be in accordance with IEC 61892-3 and power transformers in accordance with IEC 61378-1 and the IEC 60076 series.

Further requirements are given in IEC 60092-501, Clause 9.

9.12 Testing

The standard tests for individual items of equipment shall be carried out as specified in IEC 61892-6.

NOTE 1 As far as practicable, all standard acceptance tests should be carried out at the manufacturer's works.

NOTE 2 The dock and sea trial test should be carried out including duration runs and manoeuvring tests. These should include a reversal of the unit from full speed ahead to full speed astern, tests for operation of all protective devices and stability tests for control. All tests necessary to demonstrate that each item of plant and the system as a whole are satisfactory for duty, should be performed. Immediately prior to and after trials the insulation resistance should be measured and recorded.

10 Dynamic positioning

Attention is drawn to the provisions in the IMO Guidelines for vessels with dynamic positioning systems (see IMO/MSC/Circ. 645, Annex).

NOTE 1 IMO has established guidelines for equipment levels and redundancy on DP-vessels. There are three equipment levels, denoted as equipment classes 1, 2 and 3. The class of vessel required for a particular operation should be determined on the basis of a risk analysis into the consequences of a loss of position:

Equipment class 1: loss of position may occur in the event of a single fault;

Equipment class 2: loss of position is not to occur in the event of a single fault in any active component or system;

Equipment class 3: redundancy of all components and physical separation of the components against compartment fire or flood.

NOTE 2 In order to verify the performance of the DP system integrated in the total control system of the unit, an enhanced system verification test can be carried out. See Annex A for further details.

11 Ballast systems

11.1 General

Units shall be provided with an efficient pumping system capable of ballasting and deballasting any ballast tank under normal operating and transit conditions.

NOTE On jack-up units, ballast systems may not be required.

11.2 Ballast pumps

11.2.1 Motors of ballast pumps shall be capable of connection to an emergency switchboard.

11.2.2 The ballast system shall be capable of operation after the loss of any single component in the power supply system.

11.2.3 The ballast system shall still be capable of operation when the unit is

– under the inclination expected in the operational condition as stated in Clause 5; and

– powered via the emergency switchboard, with the unit in the "damaged condition" specified by the appropriate authority.

11.3 Control and indicating systems

11.3.1 A central ballast control station shall be provided. It shall be located above the worst damage waterline and adequately protected from the weather. It shall be provided with the following control and indicating system where applicable:

a) ballast pump control system;

b) ballast pump status-indicating system;

c) ballast valve control system;

d) ballast valve position-indicating system;

e) tank level indicating system;

f) draught indicating system;

g) heel and trim indicators;

h) power availability-indicating system (main and emergency);

i) ballast system hydraulic/pneumatic pressure-indicating system.

11.3.2 In addition to remote control of the ballast pumps and valves from the central ballast control station, all ballast pumps and valves shall be fitted with independent local control operable in the event of remote control failure. The independent local control of each ballast pump and of its associated ballast tank valves shall be in the same location.

11.3.3 The control and indicating systems listed in 11.3.1 shall function independently of one another, or have sufficient redundancy, such that a failure in one system does not jeopardize the operation of any of the other systems.

11.3.4 Each power-actuated ballast valve shall fail to the closed position upon loss of control power. Upon the reactivation of control power, each such valve shall remain closed until the ballast control operator assumes control of the reactivated system. The appropriate authority may accept ballast valve arrangements that do not fail to the closed position upon loss of power, provided the appropriate authority is satisfied that the safety of the unit is not impaired.

11.3.5 The tank level-indicating system specified in 11.3.1e) shall provide means to

a) indicate liquid levels in all ballast tanks. A secondary means of determining levels in ballast tanks, which may be a sounding pipe, shall be provided. Tank level sensors shall not be situated in the tank suction lines;

b) indicate liquid level in other tanks, such as fuel oil, fresh water, drilling water or liquid storage tanks, the filling or emptying of which, in the view of the appropriate authority, can affect the stability of the unit. Tank level sensors shall not be situated in the tank suction lines.

11.3.6 The draught-indicating system specified in 11.3.1f) shall indicate the draught either at each corner of the unit or at a representative position as required by the appropriate authority.

Enclosures housing ballast system electrical components, the failure of which may cause unsafe operation of the ballast system upon liquid entry into the enclosure, shall have a minimum degree of protection as specified in IEC 61892-2.

11.3.7 A means to indicate whether a valve is open or closed shall be provided at each location from which the valve can be controlled. The indicators shall rely on movement of the valve spindle.

11.3.8 Means shall be provided at the central ballast control station to isolate or disconnect the ballast pump control and ballast valve control system from their sources of electrical, pneumatic or hydraulic power.

11.4 Internal communication

A permanently installed means of communication, independent of the unit's main source of electrical power, shall be provided between the central ballast control station and spaces that contain ballast pumps or valves, or other spaces that may contain equipment necessary for the operation of the ballast system.

11.5 Protection against flooding

11.5.1 Each seawater inlet and discharge in space below the assigned load line shall be provided with a valve operable from an accessible position outside the space on the following units:

a) all column-stabilized units;

b) all other units where the space containing the valve is normally unattended and is not provided with high bilge water level detection.

11.5.2 The control systems and indicators provided for watertight doors and hatch covers, shall be operable in both normal conditions and in the event of main power failure. Where stored energy is provided for this purpose, its capacity shall be to the satisfaction of the appropriate authority.

12 Jacking systems

12.1 General

The elevating system of self-elevating units is to be designed and constructed with sufficient redundancy so that upon failure of any one component in the jacking system, electric and hydraulic power supply systems or control systems, the system shall be capable of continuing to jack or holding in place.

NOTE The jack or jacks acting on any leg should be capable of applying a load for which the leg has been designed.

12.2 Design

The system shall be designed so that overloading of the electrical components is avoided during all kinds of operations.

The electrical items to be considered in this respect include the following:

– motor controller;

– characteristic of electric motors;