

Electrical installations in ships —

Part 501: Special features — Electric propulsion plant

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National foreword

This British Standard is the UK implementation of IEC 60092-501:2007. It supersedes BS IEC 60092-501:1984 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee JPEL/18, Electrical installations of ships and of mobile and fixed offshore units.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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**Electrical installations in ships –
Part 501: Special features – Electric propulsion plant**

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INTRODUCTION

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

ELECTRICAL INSTALLATIONS IN SHIPS –

Part 501: Special features – Electric propulsion plant

1 Scope

This part of IEC 60092 specifies requirements for all electric propulsion plant and gives the specifications, system design, installation and testing of at least

- generators and their prime movers;
- switchboards;
- transformers/reactors;
- semiconductor convertors;
- propulsion motors;
- excitation systems;
- control, monitoring and safety systems;
- wires, cables, busbars, trunking systems.

Bow and stern thrusters intended as auxiliary steering devices, booster and take-home devices, all auxiliary generating plants, and accumulator battery powered propulsion machinery and equipment are excluded.

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 (all parts), *Rotating electrical machines*

IEC 60034-1:2004, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60076 (all parts), *Power transformers*

IEC 60092 (all parts), *Electrical installations in ships*

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

IEC 60092-202, *Electrical installations in ships – Part 202: System design – Protection*

IEC 60092-204, *Electrical installations in ships – Part 204: System design – Electric and electrohydraulic steering gear*

IEC 60092-301, *Electrical installations in ships – Part 301: Equipment – Generators and motors*

IEC 60092-302, *Electrical installations in ships – Part 302: Low-voltage switchgear and controlgear assemblies*

BS IEC 60092-501:2007

IEC 60092-303, *Electrical installations in ships – Part 303: Equipment - Transformers for power and lighting*

IEC 60092-504:2001, *Electrical installations in ships – Part 504: Special features – Control and instrumentation*

IEC 60146 (all parts), *Semiconductor convertors*

IEC 60146-2, *Semiconductor convertors – Part 2: Self-commutated semiconductor converters including direct d.c. converters*

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

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

IEC 62271-200:2003, *High-voltage switchgear and controlgear – Part 200: A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*

International Maritime Organization, *International convention of the safety of life at sea (SOLAS):2004, Chapter II-I/ Regulations 27, 29 and 30*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

3.1

azimuth drive

system which moves the propulsion unit around the vertical axis

3.2

double sensor

two sensor elements in one housing

3.3

local control station

place of control where a system is installed which creates a reference value for the convertors independent from the remote control system and any external limitations

3.4

locked electrical spaces

spaces constructed as dry spaces which are provided with lockable doors and are intended solely for installation of electrical equipment

3.5

main control station

place of control of the main propulsion system which is manned under seagoing conditions

3.6

nominated body

installer or manufacturer that has been given direct responsibility for the complete propulsion system.

3.7

one failure principle

during and after a fault in a circuit, the supply to the healthy circuits is permanently ensured (continuity of supply) and after a fault in a circuit has been cleared, the supply to the healthy circuits is re-established (continuity of service)

3.8

podded drive

propulsion system in which the motor is located in a dedicated, submerged unit (pod housing) of the ship

3.9

power management system (PMS)

control and safety system which provides the load depending starts and stops of the prime movers, the load sharing, etc.

3.10

propulsion generator

generator mainly used for power supply of the propulsion system

3.11

propulsion motor

electrical motor intended to provide propulsion power

3.12

propulsion switchboard

switchboard mainly used for power distribution to the propulsion systems

3.13

redundant sensor

two single sensors in separate housings

3.14

remote control system

system which comprises all equipment necessary to operate units from a control position where the operator cannot directly observe the effect of his actions

4 System

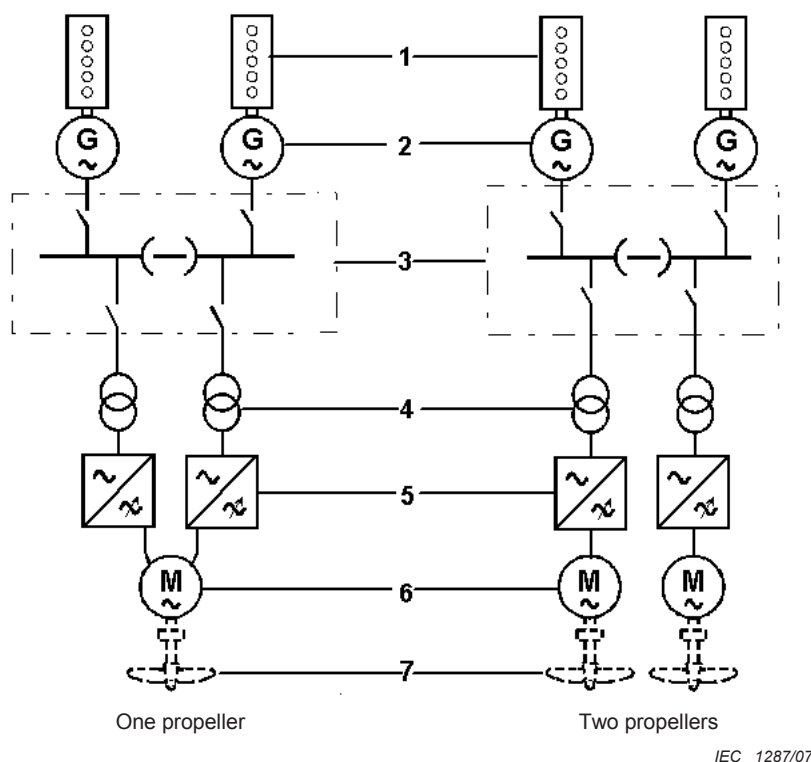
4.1 System design

4.1.1 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 | 4 Propulsion transformer | 7 Propeller |
| 2 Propulsion generator | 5 Propulsion converter | |
| 3 Switchboard | 6 Propulsion motor | |

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

4.1.2 Design requirements

The one failure principle shall be the basis of the design.

NOTE Recognizable failures should not injure the one failure principle. Undetected failures should be avoided. However, it may be unavoidable that some undetected failures may injure the one failure principle.

It shall be possible for all machinery essential for the safe operation of the ship to be controlled from a local position, even in the case of failure in any part of the automatic remote control system, see Clause 14.

4.1.3 Special requirements for ships with only one propulsion motor

Synchronous and induction motors shall be equipped with two stator winding systems which can be disconnected from the respective converter. Each converter shall be designed for at least 50 % nominal power of the propulsion drive.

DC motors shall have two separate rectifiers, each for 50 % nominal motor current, with means for disconnecting each rectifier. The converters shall be mutually independent. Any single failure in one converter shall not result in complete loss of propulsion power.

Motors with permanent excitation shall be equipped with two stator winding systems which can be disconnected from the respective converter. Additionally, there shall be a braking or

blocking system which can fix the shaft under all weather and normal towing conditions. Alternatively, a decoupling system may be used which ensures standstill of motor shaft.

4.1.4 Special requirements for ships with more than one propulsion motor

Any electrical failure in a propulsion convertor or propulsion motor shall not make all shafts unavailable.

For all types of propulsion, there shall be a braking or blocking system which can fix the shaft under all weather conditions, propulsion by the remaining shafts and normal towing conditions.

4.2 System responsibility

There shall be one nominated body responsible for the integration of the complete propulsion system.

This body shall have the necessary expertise and resources enabling a controlled integration process.

4.3 Torsional stress and torsional vibrations

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

The entire oscillating system may include prime movers, generators, transformers, convertors, exciters, motors, slip-couplings, gears, shafts and propellers.

The manufacturers of the components shall provide all necessary information to the system responsible body, see 4.2.

The highest oscillating torque can be expected in case of two-phase short circuit of the motor. The highest steady state torque can be expected in case of three-phase short circuit of the motor.

NOTE It is assumed that torque during short circuit conditions will be less than the torque during the crash stop manoeuvre

These possible load situations shall be managed by the propulsion plant. Evidence shall be made by torsional vibration calculation.

4.4 Operational stability

The control system shall be able to control the propulsion system under all weather and manoeuvring conditions.

Other onboard systems shall not influence the propulsion or manoeuvrability of the ship, for example no common communication links, no common hardware. Special consideration shall be given to electromagnetic interference.

All means for normal operation of the propulsion system, including necessary power generation, shall have interlocks in order to prevent incorrect operation and damages.