



RULES FOR  
CLASSIFICATION OF

**SHIPS**

NEWBUILDINGS

MACHINERY AND SYSTEMS  
MAIN CLASS

PART 4 CHAPTER 1

# MACHINERY SYSTEMS, GENERAL

JANUARY 2005

*This booklet includes the relevant amendments and corrections  
shown in the July 2009 version of Pt.0 Ch.1 Sec.3.*

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# CHANGES IN THE RULES

## General

The present edition of the rules includes additions and amendments decided by the Board as of November 2004, and supersedes the January 2003 edition of the same chapter.

The rule changes come into force on 1 July 2005

This chapter is valid until superseded by a revised chapter. Supplements will not be issued except for an updated list of minor amendments and corrections presented in Pt.0 Ch.1 Sec.3. Pt.0 Ch.1 is normally revised in January and July each year.

Revised chapters will be forwarded to all subscribers to the rules. Buyers of reprints are advised to check the updated list of rule chapters printed Pt.0 Ch.1 Sec.1 to ensure that the chapter is current.

## Main changes

- **Sec.4 Control of Machinery**
  - This section has been aligned with SOLAS II-1/31.2.10.
  - The requirements for engine telegraph have been included (moved from Pt.3 Ch.3 “Hull Equipment and Safety”).

## Corrections and Clarifications

In addition to the above stated rule requirements, a number of corrections and clarifications have been made in the existing rule text.

Comments to the rules may be sent by e-mail to [rules@dnv.com](mailto:rules@dnv.com)

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## SECTION 1 GENERAL REQUIREMENTS

### A. Classification

#### A 100 Application

**101** This chapter contains overall requirements common for machinery, systems and components. Detailed requirements are given in the relevant rule chapters in Pt.4 and Pt.3 Ch.3 Sec.10.

**102** The rules in this chapter apply to machinery, systems and components for ships and barges for the assignment of main class.

**103** Compliance with the rules is required for installations and equipment necessary for performing the main functions given in Pt.1 Ch.1 Sec.1 A200.

**104** The rules give system requirements and prescribe minimum requirements for materials, design, manufacture, inspection and testing.

**105** The requirements of this chapter are in compliance with relevant parts of SOLAS Ch. II-1.

**106** For components to be installed onboard vessels with the additional class notation **Naval**, additional requirements given in Pt.5 Ch.14 shall be fulfilled.

### B. Definitions

#### B 100 Terms

**101** *Failure* in the rule context is a sudden event or deterioration causing loss of function.

**102** *Repairable failure* in the machinery is a failure which is possible to be repair on board and for which the following conditions are fulfilled:

- the machinery is arranged and designed to allow for repair work at sea
- spare parts or complete spare units necessary for permanent or provisional repairs are kept on board
- tools, instruction manuals and other necessary facilities to perform the repair work are found on board.

**103** *Mean time to failure (MTTF)* is the mean value of service time until failure occurs. In the rule context, MTTF is considered to be equal to mean time between failures (MTBF).

**104** *Mean time to repair (MTTR)* is the mean value of time from occurrence of failure to re-establishment of lost function.

**105** *Reliability* is the ability of a component or a system to perform its required function without failure during a specified time interval.

**106** *Availability* is the ratio of actual service time to expected service time at sea. Availability may be calculated from the following formula:

$$A = \frac{MTTF}{MTTF + MTTR}$$

**107** *Redundancy* is the ability to maintain or restore a function when one failure has occurred. Redundancy can be achieved for instance by installation of more than one unit (component redundancy) or by having two or more separate

systems capable of performing the same function (system redundancy).

**108** *Redundancy types* are defined by the time lag accepted upon restoring a lost function, due to failure in a component or system, designed with redundancy.

<i>Redundancy type</i>	<i>Time lag in re-establishment of function</i>
0	None (continuously available)
1	Up to 30 s
2	Up to 10 minutes
3	Up to 3 hours
not defined	More than 3 hours

**109** *Active components* are components for mechanical transfer of energy, e.g. pumps, fans, electric motors, generators, combustion engines and turbines. Heat exchangers, boilers, transformers, switchgear or cables are not considered to be active components.

**110** *Mutual independence* between components means that the function of the components and their power supply is not dependent on some common component or system.

**111** *Piping* is defined to include the following components:

- pipes
- flanges with gaskets and bolts and other pipe connections
- expansion elements
- valves, including hydraulic and pneumatic actuators, and fittings
- hangers and supports
- flexible hoses
- pump housings.

**112** *A piping system* is defined to include piping, as well as components in direct connection to the piping such as pumps, heat exchangers, evaporators, independent tanks etc. with the exception of main components such as steam and gas turbines, diesel engines, reduction gears and boilers.

For components which are subject to internal pressure and are not included in the piping, the design requirements in Ch.7 apply.

**113** “Machinery spaces of category A” are those spaces and trunks to such spaces which contain:

- 1) internal combustion machinery used for main propulsion; or
- 2) internal combustion machinery used for purposes other than main propulsion where such machinery has in the aggregate a total power output of not less than 375 kW; or
- 3) any oil-fired boiler or oil fuel unit.

(SOLAS Ch. II-1/3.17)

**114** “Machinery spaces” are all machinery spaces of category A and all other spaces containing propulsion machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air conditioning machinery, and similar spaces, and trunks to such spaces.

(SOLAS Ch. II-1/3.16)

**115** *Engine room* is the spaces containing propulsion machinery and machinery for generation of electrical power.

**Guidance note:**

Rooms within or adjacent to the engine room with visual contact with the machinery are considered to be part of the engine room.

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**116** *Shut down*, implies that a unit is brought to a safe state. The safe state may be stop of a unit or decelerate rotating machinery to idle.

**117** *Load reduction*, implies that a unit is brought to a safe state under the prevailing conditions, but the reduction is limited to a degree where the function the unit serves is not lost, only degraded.

**118** *An independently driven component* is, when the function of the component and the power supply of the component is independent of the main engine.

## C. Documentation

### C 100 Documentation for approval

**101** The control and monitoring system for the following shall be submitted for approval:

- remote control of essential machinery
- bridge control of propulsion machinery
- engineers' alarm.

For requirements to documentation types, see Ch.9.

## D. Certification

### D 100 Certification of control and monitoring system

**101** The control and monitoring systems for:

- remote control of essential machinery
- bridge control of propulsion machinery
- local fire extinguishing system.

are to be certified according to Ch.9.

## SECTION 2 MATERIALS

### A. General

#### A 100 Machinery parts

**101** Requirements for documentation of quality and testing of materials intended for:

- propulsion and auxiliary machinery
- boilers and pressure vessels
- electrical installations
- instrumentation and automation
- fire protection, detection and extinction
- piping systems

are given in the respective chapters of Pt.4.

#### A 200 Use of asbestos

**201** The use of asbestos is prohibited except for:

- vanes used in rotary vane compressors and rotary vane vacuum pumps
- watertight joints and linings used for the circulation of fluids when, at high temperature (in excess of 350°C) or pressure (in excess of  $7 \times 10^6$  Pa), there is a fire risk, corrosion or toxicity
- supple and flexible thermal insulation assemblies used for temperatures above 1 000°C.

(SOLAS Ch. II-1/3-5)

## SECTION 3 DESIGN PRINCIPLES

### A. Arrangement

#### A 100 General

**101** All machinery, systems and components that are to be operated or subject to inspection and maintenance on board are to be installed and arranged for easy access.

**102** All components in a system are to be satisfactorily matched with regard to function, capacity and strength. Relative motions between parts of the machinery are to be allowed for without inducing detrimental stresses.

**103** All machinery is to be equipped with control and instrumentation considered necessary for safe operation of the machinery.

**104** All spaces, from which machinery is operated and where flammable or toxic gases or vapours may accumulate, or where a low oxygen atmosphere may occur, are to be provided with adequate ventilation under all conditions.

**105** The capacity and arrangement of machinery spaces and emergency generator room ventilation is to cover demands for operating the machinery, boilers and emergency generator at full power in all weather conditions.

Ventilation inlets and outlets are to be located not less than 4.5 m above freeboard deck. Supply of air to the engine room is to be ensured even in the event of failure of one ventilation fan. As an alternative to the redundancy requirements in B300 alternative provision of air by adequate openings will be specially considered.

**Guidance note:**

Necessary capacity of ventilation may be calculated according to ISO Standard 8861.

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#### A 200 Prevention of inadvertent operations

**201** The machinery shall be so arranged that inadvertent operation, caused by human error, cannot lead to the reduced safety of the ship and personnel.

**202** The machinery and piping systems are to be arranged to prevent sea water, cargo or ballast from reaching dry spaces of the ship or cargo (oils or chemicals) from being discharged overboard as a consequence of inadvertent operations.

**203** Systems and tanks are to be so arranged that leakage or operation of valves will not directly lead to increased risk of damage to machinery, ship or personnel due to mixing of different fluids.

**204** Open or closed position of valves is to be easily visible.

**205** If a valve's function in the system is not evident, there is to be adequate information on a name plate attached to the valve.

**206** All connections to sea are to be marked:

**SEA DIRECT.**

#### A 300 Communication and engineers' alarm

**301** Means of communication according to Pt.3 Ch.3 Sec.10 shall be provided.

(SOLAS Ch. II-1/37)

**302** An engineers' alarm capable of being operated from the engine control room or at the manoeuvring platform, as appropriate, to alert personnel in the engineers' accommodation that assistance is needed in the engine room, shall be provided. (SOLAS Ch. II-1/38)

#### A 400 Fire protection

**401** Where references have been given to SOLAS, this shall be taken as SOLAS 74 including amendments currently in force.

**402** Fuel oil, lubrication oil, hydraulic oil and thermal oil are in this context regarded as "Flammable oils".

**403** No tank containing flammable oil shall be situated where spillage or leakage therefrom can constitute a fire or explosion hazard, by coming into contact with heated surfaces (SOLAS Ch.II-2/Reg.4.2.2.3.3).

**404** Flammable oil lines shall not be located immediately above or near units of high temperature, including boilers, steam pipelines, exhaust manifolds, silencers or other equipment required to be insulated by 406. As far as practicable, flammable oil lines shall be arranged far apart from hot surfaces, electrical installations or other sources of ignition and shall be screened or otherwise suitable protected to avoid oil spray or oil leakage onto the sources of ignition (SOLAS Ch.II-2/Reg.4.2.2.5.3).

**405** For detailed arrangement of tanks and piping conveying flammable oils, see Ch.6.

**406** Surfaces with temperatures above 220 C which may be impinged as a result of a flammable oil system failure shall be properly insulated (SOLAS Ch.II-2/Reg.4.2.2.6.1).

**407** Precautions shall be taken to prevent any flammable oil that may escape under pressure from any pump, filter or heater from coming into contact with heated surfaces (SOLAS Ch.II-2/Reg.4.2.2.6.2).

**408** The surface of insulation materials shall be impervious to oil or oil vapours (SOLAS Ch.II-2/Reg.4.4.3).

**409** The floor plating of normal passageways in machinery spaces of category A shall be made of steel (SOLAS Ch.II-2/Reg.11.4.2).

**410** Hydraulic power units shall be provided with adequate shielding in order to avoid potential oil leakage, or spray coming into contact with any sources of ignition.

**411** When purifiers for heated fuel oil are not located in a separate room, consideration shall be given with regard to their location, ventilation conditions, containment of possible leakage and shielding from ignition sources.

For machinery spaces of category A above 500 m<sup>3</sup>, the purifiers shall be protected by a fixed local application fire-extinguishing system.

**Guidance note:**

Reference is made to SOLAS Ch.II-2/Reg.10.5.6 and IMO MSC/Circ.913 for requirements regarding the fixed local application fire-extinguishing system.

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#### A 500 Requirements dependent upon damage stability calculations

**501** For vessels where damage stability requirements apply, precautions are to be taken to prevent intercommunication through damaged pipe lines between flooded and intact compartments.

For this purpose, where any part of a pipe system is situated within the defined damaged area and the pipe line has an open end in a compartment assumed to be intact, an isolating valve situated outside the damaged area operable from the freeboard deck or from another position, accessible when the ship is in

damaged condition is to be fitted. For bilge lines the remotely operated stop valves may be substituted by a non-return valve.

**Guidance note:**

Requirements for damage stability may be found in inter alia SOLAS, the International Convention on Load Lines, MARPOL, IMO Gas and Chemical Codes and for the additional class notations **SF** and **Well Stimulation**.

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**A 600 Potentially hazardous, non-essential installations**

**601** Fixed refrigeration plants (including air condition plants) with a total prime mover rated effect of 100 kW and above shall comply with safety requirements in Pt.5 Ch.10.

This is also applicable for plants not covered by the class notations **Reefer, RM** or **RM CONTAINER** or **Tanker for Liquefied Gas**.

Refrigeration plants using Group 2 refrigerants (e.g. ammonia) shall comply with the safety requirements as given in Pt.5 Ch.10 irrespective of size.

**602** Controlled atmosphere installations for dry cargoes not covered by the requirements of Pt.5 Ch.10 Sec.5 for the additional class notations **CA** or **CA (port.)** shall comply with all safety requirements of Pt.5 Ch.10 Sec.5.

**603** Spaces containing refrigeration installations and not fitted with mechanical ventilations, shall be provided with an oxygen deficiency monitoring system. Alarm indication shall be located at the entrance to the space.

**B. Construction and Function**

**B 100 General**

**101** The machinery shall be so designed, installed and protected that risks of fire, explosions, accidental pollution, leakage and accidents thereof will be acceptably low.

**102** Reliability and availability of the machinery are to be adapted according to considerations of the consequences from machinery failures and disturbances.

**103** The design arrangement of machinery foundations, shaft connections, piping and ducting is to take into account the effects of thermal expansion, vibration, misalignment and hull interaction to ensure operation within safe limits.

Bolts and nuts exposed to dynamic forces and vibrations are to be properly secured.

**B 200 Environmental conditions**

**201** All machinery, components and systems covered by the rules are to be designed to operate under the following environmental conditions if not otherwise specified in the detailed requirements for the machinery, component or system:

- ambient air temperature in the machinery space between 0°C and 55°C,
- relative humidity of air in the machinery space up to 96%,
- sea water temperature up to 32°C,
- list, rolling, trim and pitch according to Table B1.

The Society may consider deviations from the angles of inclination given in the table, taking into consideration the type, size and service conditions of the ship.

**202** Where the rules have requirements for capacity or power of machinery, these are to be determined at the ambient refer-

ence conditions stated in Table B2.

<b>Table B1 List, rolling, trim and pitch <sup>1)</sup></b>				
<i>Installations, components</i>	<i>Angle of inclination (degrees) <sup>2)</sup></i>			
	<i>Athwartships</i>		<i>Fore and aft</i>	
	<i>Static</i>	<i>Dynamic</i>	<i>Static</i>	<i>Dynamic</i>
Main and auxiliary machinery	±15	0 ±22.5	±5 <sup>5)</sup>	0 ±7.5
Safety equipment, e.g. emergency power installations, emergency fire pumps and their devices, switch gear, electrical and electronic appliances <sup>3)</sup> and remote control systems	±22.5 <sup>4)</sup>	0 ±22.5 <sup>4)</sup>	±10 <sup>5)</sup>	0 ±10

- 1) The Society may consider deviations from these angles of inclination taking into consideration the type, size and service condition of the ship.
- 2) Athwartships and fore and aft inclinations may occur simultaneously.
- 3) Up to an angle of inclination of 45° no undesired switching operations or operational changes may occur.
- 4) In ships for the carriage of liquefied gases and of chemicals, the emergency power supply must also remain operable with the ship flooded to a final athwartships inclination up to a maximum of 30 degrees.
- 5) Where the length of the ship exceeds 100 m, the fore and aft static angle of inclination may be taken as 500/L degrees where L = length of ship, in m, as defined in Pt.3 Ch.1 Sec.1 B100.

<b>Table B2 Ambient reference conditions for machinery</b>	
<i>Parameter</i>	<i>Value</i>
Total barometric pressure	1 bar
Ambient air temperature	45°C
Relative humidity of air	60%
Sea water temperature	32°C

**203** The engine manufacturer is not to be expected to provide simulated ambient reference conditions at a test bed unless specified in the relevant rule chapters.

**B 300 Functional capability and redundancy**

**301** Components and systems are to be arranged with redundancy so that a single failure of any active component or system (see 305) does not cause loss of any main function, specified in Pt.1 Ch.1 Sec.1 A200 for longer periods than specified in 313.

**302** Redundancy can either be arranged as component redundancy or system redundancy as defined in Sec.1 B107.

**303** For redundancy on a component level a single failure of an active component shall not lead to a reduction of the output power for the main function served, as long as the main function is served by one system only.

**304** For duplicated systems a single failure of an active component or a system shall not reduce the output power for the main function, served by the duplicate system, to less than 40% of the nominal output rated power. 301 and 302 shall be considered as general requirements. For evaluation of deviations or equivalent solutions reference should be made to the relevant rule chapters for the component or system in question.

**Guidance note:**

For single engine propulsion plants all active components must be duplicated to satisfy 301 and 307. Multi engine propulsion plants or propulsion plants with combinations of diesel engines, gas turbines and/or electrical motors are considered to provide redundancy on a system level. For these plants, duplication of the active components is not necessary provided that at least 40% of output rated power for the main function is remaining in case of a single failure. For propulsion plants where less than 40% of output rated power remains, after a single failure, duplication of

the active components will be required. "Output rated power" is in this context the total rated propulsion power for the driven unit (e.g. one or several propellers).

All other main functions (see Pt.1 Ch.1 Sec.1 A200) are to be treated accordingly.

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**305** The following active components are general exceptions to 301 and are not required as part of the designed redundancy, unless otherwise specified in the rules:

- main engine
- shafting, gear, driven unit (e.g. propeller)
- anchor windlass
- machinery for emergency power supply
- auxiliary thrusters.

**306** Components and systems forming part of the designed redundancy are normally to be arranged as redundancy type 2 (see Sec.1 B108). When the interruption of the function, of a duplicated component or system, entails considerable hazard to other components or systems, or to the ship, redundancy type 1 is to be arranged. The installation can be arranged as redundancy type 3 if accepted in the relevant rule chapter.

**307** Active components, arranged as part of the designed redundancy, are to be so dimensioned that in the event of a single failure sufficient capacity remains to cover demands at the maximum continuous load of the component served.

**Guidance note:**

Only relevant for plants where it is required to have redundancy on a component level (e.g. single engine plants, see 302).

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**308** When two or more components are performing the same function, these are to be mutually independent and at least one is to be independently driven. Components arranged as part of the designed redundancy, yet only performing auxiliary functions to a main unit, can be directly powered by the main unit through separate power transmissions, on the condition that these components are not necessary for the starting of the main unit.

**309** The machinery is to be so arranged and designed that all functions specified in Pt.1 Ch.1 Sec.1 A200 can be maintained simultaneously in normal service at sea.

**310** Maintenance tasks normally expected to occur at short intervals, e.g. weekly, are to be carried out without loss of propulsion or steering.

**311** Changeover from one normal operational mode to another normal operational mode of the machinery is to be possible without interruption in propulsion or steering.

**312** Machinery or equipment having remote or automatic control, is in addition to have alternative provisions for attendance and operation.

**313** The machinery is to be so arranged that it can be brought into operation from the «dead ship» condition within 30 minutes using only the facilities available on board.

«Dead ship» condition is understood to mean that the entire machinery installation, including the power supply, is out of operation and that auxiliary services such as compressed air, starting current from batteries etc., for bringing the main propulsion into operation and for the restoration of the main power supply are not available.

In order to restore operation from the «dead ship» condition, an emergency generator may be used provided that it is ensured that the emergency power supply from it is available at all times. It is assumed that means are available to start the emergency generator at all times.

**314** The performance and capacity of auxiliary systems are to be adapted to the needs of the machinery installations served.

## **B 400 Failure effects**

**401** In the event of failure, components and systems are to enter the least hazardous of the possible failure states with regard to ship machinery, personnel and environment.

**402** The probability that failure in a component causes damage or failure to other components, is to be acceptably low.

**403** Failure of one component in a system arranged as part of the designed redundancy is not to lead to failure or damage to backup or parallel components or systems.

## **B 500 Component design**

**501** Components are to be designed with respect to the loads and ambient conditions which are expected to occur. Generally accepted safety margins are to be used.

**502** Exceptional conditions are to be considered when justified by the risk of damage or the consequences of damage.

**503** Where no specific requirements are given in the rules regarding dimensioning and choice of materials, generally recognised standards and engineering principles may be applied.

**504** If acceptable accuracy cannot be obtained by strength calculations, special tests for the determination of the strength of the design may be required.

**505** When it is of essential significance for the safety of the ship that the function of a component is maintained as long as possible in the event of fire, materials with high heat resistance are to be used.

**506** Materials with low heat resistance are not to be used in components where fire may cause outflow of flammable or health hazardous fluids, flooding of any watertight compartment or destruction of watertight integrity.

**Guidance note:**

Materials with high heat resistance are materials having a melting point greater than 925°C. Materials with low heat resistance are all other materials. Deviations from the above requirement will be subject to special considerations.

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## **C. Reliability and Availability**

### **C 100 Application**

**101** The requirements for reliability and availability apply to machinery for the main functions stated in Pt.1 Ch.1 Sec.1 A200 in general and to machinery for which these requirements are made applicable specifically in the rules.

### **C 200 Reliability and availability analysis**

**201** For novel and non-conventional machinery documentation in regard to reliability and availability is to be submitted upon request.

**202** Generally recognised methods and formulae are to be used in the calculation of reliability, availability and related parameters.

**203** The documentation is to include a failure mode and effect analysis (FMEA) of the component concerned.

**204** When numerical calculations cannot be performed due to insufficient data, approval may be granted on the basis of qualitative failure analyses of the component or system.

**205** Documentation of calculation methods and computer programs is to be submitted upon request.

## **D. Personnel Protection**

### **D 100 General**

**101** Machinery, boilers and associated piping systems are to

be so installed and protected as to reduce to a minimum any danger to persons onboard, due regard being paid to moving parts, hot surfaces and other hazards.

## SECTION 4 CONTROL OF MACHINERY

### A. Control and Monitoring

#### A 100 Control and monitoring

**101** Main and auxiliary machinery essential for the propulsion, control and safety of the ship shall be provided with effective means for its operation and control. All control systems essential for the propulsion, control and safety of the ship shall be independent or designed such that failure of one system does not degrade the performance of another system.

(SOLAS Ch. II-1/31.1 and 31.5.1)

**Guidance note:**

Compliance with these rules and Ch.9 is regarded as compliance with the above mentioned requirements.

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**102** 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 or remote control systems.

(SOLAS Ch. II-1/49.4)

**Guidance note:**

Local position for electrical motors driving pumps, the local position is by the starter.

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**103** At least two independent means shall be provided for communicating orders from the navigating bridge to the position in the machinery space or in the control room from which the speed and direction of thrust of the propellers are normally controlled: one of these shall be an engine-room telegraph which provides visual indication of the orders and responses both in the machinery spaces and on the navigating bridge. Appropriate means of communication shall be provided from the navigating bridge and the engine-room to any other position from which the speed or direction of thrust of the propellers may be controlled.

(SOLAS Ch. II-1/37)

#### A 200 Remote control of machinery, general requirements

**201** The requirements in this chapter are additional to those given in Ch.9 and are applicable when remote control is installed.

**202** The engine room or the engine control room, if provided, is normally the main command location but another permanently attended location may be accepted as a more suitable main command location.

It shall be possible at any time to take control of main functions locally at the machinery.

**203** In general, automatic starting, operational and control systems shall include provisions for manually overriding the automatic controls. Failure of any part of such systems shall not prevent the use of the manual override.

(SOLAS Ch. II-1/31.4)

**204** Indicators shall be fitted on the navigation bridge, the main machinery control room and at the manoeuvring platform, for:

- propeller speed and direction of rotation in the case of fixed pitch propellers; and
- propeller speed and pitch position in the case of controllable pitch propellers.

(SOLAS Ch. II-1/31.2.8 and 31.5.6)

**205** Remote starting of the propulsion machinery shall be automatically inhibited if conditions exist which may hazard the machinery, e.g. turning gear engaged.

**206** The design of the remote control system shall be such that in case of its failure an alarm will be given. Unless the Administration considers it impracticable the pre-set speed and direction of thrust of the propeller shall be maintained until local control is in operation.

(SOLAS Ch. II-1/31.2.7)

#### A 300 Bridge control of machinery

**301** Overload shall be indicated on the bridge if automatic load limitation is not arranged for.

**302** An alarm shall be initiated on the bridge and in the engine room at starting failure.

#### A 400 Bridge control of propulsion machinery

**401** The speed, direction of thrust and, if applicable, the pitch of the propeller shall be fully controllable from the navigating bridge under all sailing conditions, including manoeuvring.

(SOLAS Ch. II-1/31.2.1)

**402** The remote control shall be performed, for each independent propeller, by a control device so designed and constructed that its operation does not require particular attention to the operational details of the machinery. Where multiple propellers are designed to operate simultaneously, they may be controlled by one control device.

(SOLAS Ch. II-1/31.2.2)

**Guidance note:**

For ships less than 500 gross tonnage, two handle control may be accepted and some of the normally programmed operations may instead be carried out manually.

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**403** The main propulsion machinery shall be provided with an emergency stopping device on the navigating bridge which shall be independent of the navigating bridge control system.

(SOLAS Ch. II-1/31.2.3)

**Guidance note:**

If means are provided to stop the propulsion without stopping the main engine(s) (e.g. clutch arrangement) then this will be accepted.

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**404** Propulsion machinery orders from the navigation bridge shall be indicated in the main machinery control room and at the manoeuvring platform.

(SOLAS Ch. II-1/31.2.4)

**405** Remote control of the propulsion machinery shall be possible only from one location at a time, at such locations interconnected control positions are permitted. At each location there shall be an indicator showing which location is in control of the propulsion machinery. The transfer of control between the navigating bridge and machinery spaces shall be possible only in the main machinery space or the main machinery control room. This system shall include means to prevent the propelling thrust from altering significantly when transferring control from one location to another.

(SOLAS Ch. II-1/31.2.5)

**Guidance note:**

The space where propulsion thrusters are located may in this context be regarded as the machinery space.

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**406** It shall be possible to control the propulsion machinery locally, even in the case of failure in any part of the remote control system. It shall also be possible to control the auxiliary machinery, essential for the propulsion and safety of the ship, at or near the machinery concerned.

(SOLAS Ch. II-1/31.2.6)

**407** An alarm shall be provided on the navigating bridge and in the machinery space to indicate low starting air pressure which shall be set at a level to permit further main engine starting operations. If the remote control system of the propulsion machinery is designed for automatic starting, the number of automatic consecutive attempts which fail to produce a start shall be limited in order to safeguard sufficient starting air pressure for starting locally.

(SOLAS Ch. II-1/31.2.9)

**408** Automation systems shall be designed in a manner which ensures that threshold warning of impending or imminent slowdown or shutdown of the propulsion system is given to the officer in charge of the navigational watch in time to assess navigational circumstances in an emergency. In particular, the systems shall control, monitor, report, alert and take safety action to slow down or stop propulsion while providing the officer in charge of the navigational watch an opportunity to manually intervene, except for those cases where manual intervention will result in total failure of the engine and/or propulsion equipment within a short time, for example in the case of overspeed.

(SOLAS Ch. II-1/31.2.10)

**Guidance note:**

The above is regarded to be fulfilled when:

- 1) All parameters initiating slowdown and shutdown shall initiate an alarm at a set-point different from the slowdown/shutdown set-point. These alarms shall be individually or in groups indicated on the navigating bridge whenever the propulsion machinery is controlled from this position.

Exempted from the requirement to give a pre-warning are the following parameters:

- overspeed on rotating machinery
- crankcase explosive condition using oil mist detection on diesel engines
- short-circuit in electrical propulsion plants.

- 2) An override facility to manually intervene on all slowdowns and shutdowns shall be available for all parameters except those which will result in total failure of the engine and/or propulsion equipment within a short time.

Note: examples of such parameters:

- lubricating oil pressure for rotating machinery
- overspeed for rotating machinery for fluid film bearings
- crankcase explosive condition on diesel engines
- short-circuit conditions in electrical installation
- high vibration for gas turbines.

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**A 500 Supervision from a control room**

**501** Where the main propulsion and associated machinery, including sources of main electrical supply, are provided with various degrees of automatic or remote control and are under continuous manual supervision from a control room the arrangements and controls shall be so designed, equipped and installed that the machinery operation will be as safe and effective as if it were under direct supervision; for this purpose Regulations 46 to 50 shall apply as appropriate. Particular consideration shall be given to protect such spaces against fire and flooding.

(SOLAS Ch. II-1/31.3)

**502** Ships intended to operate as described in 501 shall satisfy the requirements given in Pt.6 Ch.3 Sec.4.

**A 600 Operation with periodically unattended machinery spaces**

**601** Ships intended to operate with periodically unattended machinery spaces shall be arranged and tested as required in Pt.6 Ch.3.

**Guidance note:**

Pt.6 Ch.3 is considered to meet the regulations of SOLAS Chapter II-1 Part E, Additional Requirements for Periodically Unattended Machinery Spaces.

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## SECTION 5 SPARE PARTS

### A. General

#### A 100 Machinery installations

**101** Spare parts in general are not mandatory for retention of class. It is, however, assumed that an inventory of spare parts sufficient to meet the needs posed by the ship's plans of operation is maintained on board. Its content should be decided taking into consideration:

- the probability of need as a consequence of likely failures
- the likely failures and effect on the main functions
- the possibility of the ship's staff effecting the necessary repairs.

Further guidance for spare parts is given in the relevant rule chapters in Pt.4.

**102** For general guidance purposes, machinery and electrical installations in vessels intended for common world wide trading are recommended to be provided with inventory of spare parts as listed in the Tables A1 to A6, including the necessary tools and instructions for replacement.

**103** For important systems and components the recommendations of the manufacturer shall be taken into account.

**104** Any applicable statutory requirement of the country of registration of the vessel is also to be considered.

**105** The Society may require specific spare parts to be carried, if deemed necessary (mandatory requirement). The extent and amount will be decided on a case by case basis.

#### Guidance note:

The Society may require spare parts in cases where it is planned to do repairs on board instead of having redundancy on a component or system level. This will only be considered for "repairable failures" and normally only for redundancy type 3.

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#### A 200 Tables of recommended spare parts

**201** Spare parts for internal combustion engines for propulsion, see Table A1.

**202** Spare parts for internal combustion engines driving electric generators, see Table A2.

**203** Spare parts for main steam turbines, and auxiliary steam turbines driving electric generators, see Table A3.

**204** Vessels with boilers supplying steam necessary for performing the main functions covered by the main class as specified in Pt.1 Ch.1 Sec.1 A200 are recommended to be provided with spare parts in accordance with Table A4.

**205** Spare parts for various machinery equipment, see Table A5.

**206** Spare parts for electrical installations, see Table A6.

<b>Table A1 Recommended spare parts for internal combustion engines for propulsion of ships for unrestricted service <sup>1)</sup></b>		
<i>Item</i>	<i>Specification</i>	<i>Number recommended</i>
Main bearings	Main bearings or shells for one bearing of each size and type fitted, complete with shims, bolts and nuts	1
Main thrust block	Pads for one face of tilting type thrust block, or	1 set
	Complete with metal thrust shoe of solid ring type, or	1
	Inner and outer race with rollers, where roller thrust bearings are fitted	1
Cylinder liner	Cylinder liner, complete with joint rings and gaskets	1
Cylinder cover	Cylinder cover, complete with valves, joint rings, gaskets and rocker arms with brackets. For engines without covers, the respective valves for one cylinder unit	1
	Cylinder cover bolts and nuts, for one cylinder	1/2 set
Cylinder valves-	Exhaust valves, complete with casings, seats, springs and other fittings for one cylinder	2 sets
	Air inlet valve, complete with casings, seats, springs and other fittings for one cylinder	1 set
	Starting air valve, complete with casing, seat, spring and other fittings	1
	Cylinder overpressure sentinel valve, complete	1
	Fuel valves of each size and type fitted, complete with all fittings, for one engine	1 set <sup>2)</sup>
Connecting rod bearings	Bottom end bearings or shells of each size and type fitted, complete with shims, bolts and nuts, for one cylinder	1 set
	Top end bearings or shells of each size and type fitted, complete with shims, bolts and nuts, for one cylinder	1 set
Pistons	<b>Crosshead type:</b> Piston of each type fitted, complete with piston rod, stuffing box, skirt, rings, studs and nuts	1
	<b>Trunk piston type:</b> Piston of each type fitted, complete with skirt, rings, studs, nuts, gudgeon pin and connecting rod	1
Piston rings	Piston rings, for one cylinder	1 set
Piston cooling	Telescopic cooling pipes and fittings or their equivalent, for one cylinder unit	1 set
Cylinder lubricators	Lubricator, complete, of the largest size, with its chain drive or gear wheels	1
Fuel injection pumps	Fuel pump complete or, when replacement at sea is practicable, a complete set of working parts for one pump (plunger, sleeve, valves, springs, etc.)	1
Fuel injection piping	High pressure fuel pipe of each size and shape fitted, complete with couplings	1
Scavenge blowers (including turbochargers)	Rotors, rotor shafts, bearings, nozzle rings and gear wheels or equivalent working parts if other types	1 set <sup>3)</sup>
Scavenging system	Suction and delivery valves for one pump of each type fitted	1 set
Reduction and/or reverse gear	Complete bearing bush, of each size fitted in the gear case assembly	1 set
	Roller or ball race, of each size fitted in the gear case assembly	1 set
Main engine driven air compressors	Piston rings of each size fitted	1 set
	Suction and delivery valves complete of each size fitted	1/2 set
Gaskets and packing	Special gaskets and packing of each size and type fitted for cylinder covers and cylinder liners for one cylinder	-
<p>1) In case of multi-engine installations, the minimum recommended spares are only necessary for one engine.</p> <p>2)</p> <p>a) Engines with one or two fuel valves pr. cylinder: one set of fuel valves, complete</p> <p>b) Engines with three or more fuel valves pr. cylinder: two fuel valves complete per cylinder and sufficient number of valve parts, excluding the body, to form with, those fitted in the complete valves, a full engine set.</p> <p>3) The spare parts may be omitted where it has been demonstrated, at the builders test bench for one engine of the type concerned, that the engine can be manoeuvred satisfactorily with one blower out of action. The requisite blanking and blocking arrangements for running with one blower out of action are to be available on board.</p>		

**Guidance note:**

The availability of other spare parts, such as gears and chains for camshaft drive, should be especially considered and decided

upon by the owner.

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<b>Table A2 Recommended spare parts for internal combustion engines driving electric generators of ships with unrestricted service <sup>1)</sup></b>		
<i>Item</i>	<i>Specification</i>	<i>Number recommended</i>
Main bearings	Main bearings or shells for one bearing of each size and type fitted, complete with shims, bolts and nuts	1
Cylinder valves	Exhaust valves, complete with casings, seats, springs and other fittings for one cylinder	2 sets
	Air inlet valves, complete with casings, seats, springs and other fittings for one cylinder	1 set
	Starting air valve, complete with casing, seat, springs and other fittings	1
	Cylinder overpressure sentinel valve, complete	1
	Fuel valves of each size and type fitted, complete, with all fittings, for one engine	1/2 set
Connecting rod bearings	Bottom end bearings or shells of each size and type fitted, complete with shims, bolts and nuts, for one cylinder	1 set
	Top end bearings or shells of each type fitted, complete with shims, bolts and nuts, for one cylinder	1 set
	<b>Trunk piston type:</b> Gudgeon pin with bushing for one cylinder	1 set
Piston rings	Piston rings, for one cylinder	1 set
Piston cooling	Telescopic cooling pipes and fittings or their equivalent, for one cylinder unit	1 set
Fuel injection pumps	Fuel pump complete or, when replacement at sea is practicable, a complete set of working parts for one pump (plunger, sleeve, valve springs, etc.)	1
Fuel injection piping	High pressure fuel pipe of each size and type fitted, complete with couplings	1
Gaskets and packings	Special gaskets and packings of each and type fitted, for cylinder covers and cylinder liners for one cylinder	1 set
1) Where the number of generators of adequate capacity fitted for essential service exceed the required number, no spare are required for the auxiliary engines.		

<b>Table A3 Recommended spare parts for main steam turbines and auxiliary steam turbines driving electric generators of ships with unrestricted service <sup>1) 2) 3)</sup></b>		
<i>Item</i>	<i>Specification</i>	<i>Number recommended</i>
Main bearings	Bearing bushes or roller bearings of each size and type fitted, the rotor, pinion and gear wheel shafts, for one turbine	1
Turbine thrust	Pads of each size for one face of tilting type thrust, with liners, or rings for turbine adjusting block, of each size fitted with assorted liners, for one turbine	1 set
Main thrust block	<b>Tilting type:</b> Pads for one face <sup>4)</sup>	1 set
	<b>Roller type:</b> Inner and outer race with rollers	1
Turbine shaft sealing rings	Carbon sealing rings, where fitted, with springs, for each size and type of gland	1 set
Oil filters	Strainer baskets or inserts, for filters of special design, of each type and size	1 set
1) In case of multi-turbine installations, the minimum required spare parts are only necessary for on turbine of each type.		
2) The list covers auxiliary turbines as far as applicable.		
3) Where the number of generators of adequate capacity fitted for essential service exceed the required number, no spare are required for the auxiliary engines.		
4) When the pads of one face differ from those of the other, a complete set of pads is to be provided.		

<b>Table A4 Recommended spare parts for boilers and steam-heated steam generators of ships with unrestricted service</b>	
<i>Specification</i>	<i>Number recommended</i>
Safety valves: springs of each size	1
Water gauge glasses of round type with packings	3 sets
Water gauge glasses of flat type with packings	1 set
Strainers: strainer basket of each size for fuel oil system	1
Fuel oil burner: parts subjected to wear, for each burner	1 set
Pressure gauge for steam drum	1
Tube stoppers or plugs of each size for boilers, superheater and economiser	2%

<b>Table A5 Recommended spare parts for various machinery equipment of ships with unrestricted service</b>		
<i>Item</i>	<i>Specification</i>	<i>Number recommended</i>
Pumps <sup>1)</sup> - fuel oil transfer - feed water - cooling water - bilge water - lubrication oil	<b>Piston pumps:</b> Valve with seats and springs each size fitted Piston rings each type and size for one piston	1 set 1 set
	<b>Centrifugal pumps:</b> Bearings of each type and size Rotor sealings of each type and size	1 1
	<b>Gear type pumps:</b> Bearings of each type and size Rotor sealings of each type and size	1 1
Air compressors for essential service	Suction and delivery valves complete for each size fitted in one unit	1/2 set
	Piston rings for each type and size fitted for one piston	1 set
1) When a sufficiently rated standby pump is available, the spare parts may be dispensed with.		

<b>Table A6 Recommended spare parts for electrical installations of ships with unrestricted service</b>		
<i>Item</i>	<i>Specification</i>	<i>Number recommended</i>
Generators	The spare parts are generally to be supplied for each size and type of generator required according to Ch.8.	1 complete brush holder, 1 set of brushes, 1 set of any special tools required, 1 set of necessary spare parts for excitation and automatic voltage regulation equipment.
	For generators having excitation and voltage regulation equipment with semiconductors, the following is generally recommended.	1/3 of the number of main diodes for excitation, 1 complete set of all other semiconductor components, or alternatively 1 complete specimen of each assembled unit of such components, if the units are such that it is impracticable to carry out repairs on board.
Switchboards	For each repairable circuit-breaker on each pole:	1 set of contacts, subject to wear, 1 set of other parts, subject to wear, 1 set of springs, 1 coil of each type used, 1 resistance element of each type used.  For 6 or less circuits-breakers of same type, 1 set of such spare parts.
	For each type of non-repairable circuit-breaker (e.g. »miniature« circuit-breakers):	5% of each size with a minimum of 2 of each size used.
	For each type of fuses:	10% of each size with a minimum of 12 of each size used, 3 fuse-bases of each size used.
Cables		1 set of any special tools and equipment for repairing mineral-insulated cables, where such cables are installed.
Motors	For each essential and important D.C. and A.C. motor with commutator or slipring:	1 complete brush holder, 1 set of brushes, 1 set of any special tools.  For 6 or less motors of the same size and type, 1 set of such spare parts.
	In addition to the spares stated above for essential and important D.C. and A.C. motors are recommended for each size of steering gear motor and motor generator, if no standby electrical machine is installed:	<i>D.C. machinery:</i> 1 armature of each size fitted, complete with shaft and halt coupling, 1 field coil of each type fitted, <i>A.C. machinery:</i> 1 stator complete of each size fitted.
	For electric starting of main engines on ships having only one main propelling engine, with no other means of starting:	1 complete starting motor.

<b>Table A6 Recommended spare parts for electrical installations of ships with unrestricted service (Continued)</b>		
Control gear	For each repairable control gear of motors and other consumers, intended for essential and important services:	1 set of the contacts which are subject to wear, 1 set of springs, 10% of each different resistance element, with at least 1 of each, 1 of each type coil used.  When 6 or less motors or other consumers are fitted with control gear having interchangeable parts, it is normal to provide one set of spares for the control gear which is provided with the greatest number of parts.
	For each type of non-repairable control gear of motors and other consumers intended for essential and important services (e.g. some types of small motor starters):	5% of each size with a minimum of 2 of each size used.
Portable insulation-resistance measuring instrument		Ships with electrical installation of 100 kW and above are recommended to carry insulation-resistance measuring instrument, having a D.C. test voltage of not less than the installation's voltage.
Miscellaneous	For navigation lights with their pilot lamps:	1 complete set of lamps.
	Where the emergency lighting voltage is different from the main lighting voltage:	10% of the emergency lamps, with a minimum of 10.