PART 4 CHAPTER 1

MACHINERY SYSTEMS, GENERAL

JANUARY 2003

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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 December 2002, and supersedes the January 2001 edition of the same chapter.
The rule changes come into force on 1 July 2003
This chapter is valid until superseded by a revised chapter.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.3 Design Principles
  - Table B1 has been amended to include switch gear and electrical appliances, additionally, new notes: numbers 1, 3, 4 and 5 have also been added.

- Sec.5 Spare Parts
  - Lists of minimum recommended spare parts have been reproduced from IACS Recommendations: 26, 27, 28, 29 and 30, in Tables A1, A2, A3, A4, A5 and A6.

Corrections and Clarifications
In addition to the above stated rule requirements, a number of detected errors, corrections and clarifications have been made in the existing rule text.
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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 Sec10 and Sec.12.

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.2 A300.

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. SOLAS.

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 repaired on board and for which the following conditions are fulfilled:

— the machinery is arranged and designed to allow to 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.

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

109 Independent operation of a component is when the function of the component and the power supply of the component is independent of main engine.

110 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.

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

112 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.

113 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.

114 “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 Reg. II-1.3.17)

115 “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 Reg. II-1.3.16)
116 *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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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 pre-fabricated asbestos packings or gaskets in high temperature piping systems and friction coating not requiring any adaption work on board.
SECTION 3 
DESIGN PRINCIPLES

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.

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.

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.

The machinery and piping systems are to be arranged to preclude the possibility of 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.

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.12 shall be provided.

(SOLAS Reg. 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 reg. II-1/38)

A 400 Fire protection

401 Facilities for the safe storage and handling of flammable fluids are to be found on board.

402 All spaces where oil-burning installations, settling tanks or daily service fuel oil tanks are located, are to be easily accessible and well ventilated.

403 Where small leaks of flammable fluids may occur during normal service or routine maintenance work, special arrangements are to be made to prevent these fluids from reaching other parts of the machinery where danger of ignition may arise.

404 Piping and other installations for the transport of flammable fluids are to be so located that the fire hazard resulting from rupture and other failures, is acceptably low.

405 For arrangement of fuel oil piping, see Ch.6.

406 Exhaust pipes are not to be led in the vicinity of fuel oil tanks, cargo hold bulkheads etc.

407 All surfaces which may reach a temperature of 220°C or more, are to be insulated or equivalently protected so that flammable fluids cannot be ignited.

408 Where oil absorbing insulation material is used, the insulation is to be covered by non-combustible vapourtight sheeting.

409 All other possible ignition sources of the machinery are to be protected in order to prevent ignition of flammable fluids.

410 Flammable or oil absorbing materials are not to be used in floors, gratings etc. in boiler and engine rooms, shaft tunnels or in compartments where settling tanks are installed.

411 Fuel oil purifiers for heated fuel oil or hydraulic power aggregates with pressure higher than 15 bar and power delivery higher than 5 kW located within the boundaries of machinery spaces of category A, shall be placed in separate rooms enclosed by steel bulkheads extending from deck to deck and provided with self-closing doors. The rooms shall be provided with:

— independent mechanical ventilation
— fire detection system
— fixed fire extinguishing installation.

It shall be possible to activate the extinguishing installation from outside the room and separately from the fire extinguishing of the engine room.

From the same position it shall be possible to stop fuel pumps, ventilation fans, oil purifiers or hydraulic pumps located in the room.

412 If it is impracticable to locate the installations addressed in 411 in separate rooms, special consideration is to be given with regard to location and shielding against leakages hitting sources of ignition. The installations are to be covered by a fire extinguishing system capable of being activated automatically or activated manually from the machinery control position or from another suitable location. If automatic release is provided, additional manual release is to be arranged.

413 Approved penetrations are to be used where plastic pipes are passing through fire resistant bulkheads or decks.

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 notation SF and Well Stimulation.

---end-of-Guidance-note---

A 600 Potentially hazardous, non-essential installations

601 Fixed refrigeration plants with a total prime mover rated effect of 7.5 kW and above and not covered by the requirements of Pt.5 Ch.10 for the additional class notation Reefer, RM or RM Container or Pt.5 Ch.5 for the additional class notation Tanker for Liquefied Gas are to comply with safety requirements as given in Pt.5 Ch.10.

602 Fixed refrigeration plants are to comply with the environmental requirements of Pt.5 Ch.10 Sec.3 A403 and B304 as specified therein.

603 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.) are to comply with all safety requirements of Pt.5 Ch.10 Sec.5.

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 reference conditions stated in Table B2.

Table B1 List, rolling, trim and pitch 1)

<table>
<thead>
<tr>
<th>Installations, components</th>
<th>Angle of inclination (degrees) 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Athwartships</td>
</tr>
<tr>
<td></td>
<td>Static</td>
</tr>
<tr>
<td>Main and auxiliary machinery</td>
<td>±15</td>
</tr>
<tr>
<td>Safety equipment, e.g. emergency power installations, emergency fire pumps and their devices, switch gear, electrical and electronic appliances 3) and remote control systems</td>
<td>±22.5 4)</td>
</tr>
</tbody>
</table>

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.

Table B2 Ambient reference conditions for machinery

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total barometric pressure</td>
<td>1 bar</td>
</tr>
<tr>
<td>Ambient air temperature</td>
<td>45°C</td>
</tr>
<tr>
<td>Relative humidity of air</td>
<td>60%</td>
</tr>
<tr>
<td>Sea water temperature</td>
<td>32°C</td>
</tr>
</tbody>
</table>

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.2 for longer periods than specified in 312.

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

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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.2 A300) 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.2 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.

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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.2 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 Reg. 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.

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 is the main command location.

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 Reg. 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 Reg. 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 Reg. II-1/31.2.7)

207 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 Reg. II-1/31.2.9)

An alarm shall be initiated when the automatic starting becomes inhibited.

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 Reg. II-1/31.2.1)

402 The control shall be performed by a single control device for each independent propeller, with automatic performance of all associated services, including, where necessary, means of preventing overload of the propulsion machinery. Where multiple propellers are designed to operate simultaneously, they may be controlled by one control device.

(SOLAS Reg. 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.

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 Reg. 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.

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

(SOLAS Reg. 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 Reg. II-1/31.2.5)

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 Reg. II-1/31.2.6)

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 Reg. 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.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

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.2 A300 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.
### Table A1 Recommended spare parts for internal combustion engines for propulsion of ships for unrestricted service 1)

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
<th>Number recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main bearings</td>
<td>Main bearings or shells for one bearing of each size and type fitted, complete with shims, bolts and nuts</td>
<td>1</td>
</tr>
<tr>
<td>Main thrust block</td>
<td>Pads for one face of tilting type thrust block, or</td>
<td>1 set</td>
</tr>
<tr>
<td></td>
<td>Complete with metal thrust shoe of solid ring type, or</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Inner and outer race with rollers, where roller thrust bearings are fitted</td>
<td>1</td>
</tr>
<tr>
<td>Cylinder liner</td>
<td>Cylinder liner, complete with joint rings and gaskets</td>
<td>1</td>
</tr>
<tr>
<td>Cylinder cover</td>
<td>Cylinder cover, complete with valves, joint rings, gaskets and rocker arms with brackets. For engines without covers, the respective valves for each cylinder unit</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Cylinder cover bolts and nuts, for one cylinder</td>
<td>1/2 set</td>
</tr>
<tr>
<td>Cylinder valves</td>
<td>Exhaust valves, complete with casings, seats, springs and other fittings for one cylinder</td>
<td>2 sets</td>
</tr>
<tr>
<td></td>
<td>Air inlet valve, complete with casings, seats, springs and other fittings for one cylinder</td>
<td>1 set</td>
</tr>
<tr>
<td></td>
<td>Starting air valve, complete with casing, seat, spring and other fittings</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Cylinder overpressure sentinel valve, complete</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Fuel valves of each size and type fitted, complete with all fittings, for one engine</td>
<td>1 set 2)</td>
</tr>
<tr>
<td>Connecting rod bearings</td>
<td>Bottom end bearings or shells of each size and type fitted, complete with shims, bolts and nuts, for one cylinder</td>
<td>1 set</td>
</tr>
<tr>
<td></td>
<td>Top end bearings or shells of each size and type fitted, complete with shims, bolts and nuts, for one cylinder</td>
<td>1 set</td>
</tr>
<tr>
<td>Pistons</td>
<td>Crosshead type: Piston of each type fitted, complete with piston rod, stuffing box, skirt, rings, studs and nuts</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Trunk piston type: Piston of each type fitted, complete with skirt, rings, studs, nuts, gudgeon pin and connecting rod</td>
<td>1</td>
</tr>
<tr>
<td>Piston rings</td>
<td>Piston rings, for one cylinder</td>
<td>1 set</td>
</tr>
<tr>
<td>Piston cooling</td>
<td>Telescopic cooling pipes and fittings or their equivalent, for one cylinder unit</td>
<td>1 set</td>
</tr>
<tr>
<td>Cylinder lubricators</td>
<td>Lubricator, complete, of the largest size, with its chain drive or gear wheels</td>
<td>1</td>
</tr>
<tr>
<td>Fuel injection pumps</td>
<td>Fuel pump complete or, when replacement at sea is practicable, a complete set of working parts for one pump (plunger, sleeve, valves, springs, etc.)</td>
<td>1</td>
</tr>
<tr>
<td>Fuel injection piping</td>
<td>High pressure fuel pipe of each size and shape fitted, complete with couplings</td>
<td>1</td>
</tr>
<tr>
<td>Scavenging system</td>
<td>Suction and delivery valves for one pump of each type fitted</td>
<td>1 set 3)</td>
</tr>
<tr>
<td>Reduction and/or reverse gear</td>
<td>Complete bearing bush, of each size fitted in the gear case assembly</td>
<td>1 set</td>
</tr>
<tr>
<td></td>
<td>Roller or ball race, of each size fitted in the gear case assembly</td>
<td>1 set</td>
</tr>
<tr>
<td>Main engine driven air compressors</td>
<td>Piston rings of each size fitted</td>
<td>1 set</td>
</tr>
<tr>
<td></td>
<td>Suction and delivery valves complete of each size fitted</td>
<td>1/2 set</td>
</tr>
<tr>
<td>Gaskets and packing</td>
<td>Special gaskets and packing of each size and type fitted for cylinder covers and cylinder liners for one cylinder</td>
<td>-</td>
</tr>
</tbody>
</table>

---

1) In case of multi-engine installations, the minimum recommended spares are only necessary for one engine.

2) 
   a) Engines with one or two fuel valves pr. cylinder: one set of fuel valves, complete
   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.

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.

---

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.

---end-of-Guidance-note---
### Table A2 Recommended spare parts for internal combustion engines driving electric generators of ships with unrestricted service 1)

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
<th>Number recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main bearings</td>
<td>Main bearings or shells for one bearing of each size and type fitted, complete with shims, bolts and nuts</td>
<td>1</td>
</tr>
<tr>
<td>Cylinder valves</td>
<td>Exhaust valves, complete with casings, seats, springs and other fittings for one cylinder</td>
<td>2 sets</td>
</tr>
<tr>
<td></td>
<td>Air inlet valves, complete with casings, seats, springs and other fittings for one cylinder</td>
<td>1 set</td>
</tr>
<tr>
<td></td>
<td>Starting air valve, complete with casing, seat, springs and other fittings</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Cylinder overpressure sentinel valve, complete</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Fuel valves of each size and type fitted, complete, with all fittings, for one engine</td>
<td>1/2 set</td>
</tr>
<tr>
<td>Connecting rod bearings</td>
<td>Bottom end bearings or shells of each size and type fitted, complete with shims, bolts and nuts, for one cylinder</td>
<td>1 set</td>
</tr>
<tr>
<td></td>
<td>Top end bearings or shells of each type fitted, complete with shims, bolts and nuts, for one cylinder</td>
<td>1 set</td>
</tr>
<tr>
<td>Piston rings</td>
<td>Piston rings, for one cylinder</td>
<td>1 set</td>
</tr>
<tr>
<td>Piston cooling</td>
<td>Telescopic cooling pipes and fittings or their equivalent, for one cylinder unit</td>
<td>1 set</td>
</tr>
<tr>
<td>Fuel injection pumps</td>
<td>Fuel pump complete or, when replacement at sea is practicable, a complete set of working parts for one pump (plunger, sleeve, valve springs, etc.)</td>
<td>1</td>
</tr>
<tr>
<td>Fuel injection piping</td>
<td>High pressure fuel pipe of each size and type fitted, complete with couplings</td>
<td>1</td>
</tr>
<tr>
<td>Gaskets and packings</td>
<td>Special gaskets and packings of each and type fitted, for cylinder covers and cylinder liners for one cylinder</td>
<td>1 set</td>
</tr>
</tbody>
</table>

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.

### Table A3 Recommended spare parts for main steam turbines and auxiliary steam turbines driving electric generators of ships with unrestricted service 1) 2) 3)

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
<th>Number recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main bearings</td>
<td>Bearing bushes or roller bearings of each size and type fitted, the rotor, pinion and gear wheel shafts, for one turbine</td>
<td>1</td>
</tr>
<tr>
<td>Turbine thrust</td>
<td>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</td>
<td>1 set</td>
</tr>
<tr>
<td>Main thrust block</td>
<td><strong>Tilting type</strong>: Pads for one face 4)</td>
<td>1 set</td>
</tr>
<tr>
<td></td>
<td><strong>Roller type</strong>: Inner and outer race with rollers</td>
<td>1</td>
</tr>
<tr>
<td>Turbine shaft sealings rings</td>
<td>Carbon sealing rings, where fitted, with springs, for each size and type of gland</td>
<td>1 set</td>
</tr>
<tr>
<td>Oil filters</td>
<td>Strainer baskets or inserts, for filters of special design, of each type and size</td>
<td>1 set</td>
</tr>
</tbody>
</table>

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.

### Table A4 Recommended spare parts for boilers and steam-heated steam generators of ships with unrestricted service

<table>
<thead>
<tr>
<th>Specification</th>
<th>Number recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety valves: springs of each size</td>
<td>1</td>
</tr>
<tr>
<td>Water gauge glasses of round type with packings</td>
<td>3 sets</td>
</tr>
<tr>
<td>Water gauge glasses of flat type with packings</td>
<td>1 set</td>
</tr>
<tr>
<td>Strainers: strainer basket of each size for fuel oil system</td>
<td>1</td>
</tr>
<tr>
<td>Fuel oil burner: parts subjected to wear, for each burner</td>
<td>1 set</td>
</tr>
<tr>
<td>Pressure gauge for steam drum</td>
<td>1</td>
</tr>
<tr>
<td>Tube stoppers or plugs of each size for boilers, superheater and economiser</td>
<td>2%</td>
</tr>
</tbody>
</table>

---

**Notes:**
- 1) The minimum required spare parts are only necessary for one 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.
### Table A5 Recommended spare parts for various machinery equipment of ships with unrestricted service

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
<th>Number recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumps 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- fuel oil transfer</td>
<td>Valve with seats and springs each size fitted</td>
<td>1 set</td>
</tr>
<tr>
<td>- feed water</td>
<td>Piston rings each type and size for one piston</td>
<td>1 set</td>
</tr>
<tr>
<td>- cooling water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- bilge water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- lubrication oil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piston pumps:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centrifugal pumps:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Bearings of each type and size</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>- Rotor sealings of each type and size</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Gear type pumps:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Bearings of each type and size</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>- Rotor sealings of each type and size</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Air compressors for essential service</td>
<td>Suction and delivery valves complete for each size fitted</td>
<td>1/2 set</td>
</tr>
<tr>
<td>- in one unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Piston rings for each type and size fitted</td>
<td>1 set</td>
<td></td>
</tr>
</tbody>
</table>

1) When a sufficiently rated standby pump is available, the spare parts may be dispensed with.

### Table A6 Recommended spare parts for electrical installations of ships with unrestricted service

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
<th>Number recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generators</td>
<td>The spare parts are generally to be supplied for each size and type of generator required according to Ch.8.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For generators having excitation and voltage regulation equipment with semiconductors, the following is generally recommended.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Switchboards</td>
<td>For each repairable circuit-breaker on each pole:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For 6 or less circuits-breakers of same type, 1 set of such spare parts.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For each type of fuses:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10% of each size with a minimum of 12 of each size used, 3 fuse-bases of each size used.</td>
<td></td>
</tr>
<tr>
<td>Cables</td>
<td>1 set of any special tools and equipment for repairing mineral-insulated cables, where such cables are installed.</td>
<td></td>
</tr>
<tr>
<td>Motors</td>
<td>For each essential and important D.C. and A.C. motor with commutator or slipring:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 complete brush holder, 1 set of brushes, 1 set of any special tools.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For 6 or less motors of the same size and type, 1 set of such spare parts.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>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:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D.C. machinery: 1 armature of each size fitted, complete with shaft and half coupling, 1 field coil of each type fitted, A.C. machinery: 1 stator complete of each size fitted.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>For electric starting of main engines on ships having only one main propelling engine, with no other means of starting:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 complete starting motor.</td>
<td></td>
</tr>
</tbody>
</table>
Control gear

For each repairable control gear of motors and other consumers, intended for essential and important services:

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 set of the contacts which are subject to wear,</td>
<td>1 set of springs,</td>
</tr>
<tr>
<td>10% of each different resistance element, with at least 1 of each,</td>
<td>1 of each type coil used.</td>
</tr>
</tbody>
</table>

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):

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% of each size with a minimum of 2 of each size used.</td>
<td></td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 complete set of lamps.</td>
<td></td>
</tr>
</tbody>
</table>

Where the emergency lighting voltage is different from the main lighting voltage:

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% of the emergency lamps, with a minimum of 10.</td>
<td></td>
</tr>
</tbody>
</table>