RULES FOR
CLASSIFICATION OF

SHIPS

NEWBUILDINGS

SPECIAL EQUIPMENT AND SYSTEMS
ADDITIONAL CLASS

PART 6 CHAPTER 2

REDUNDANT PROPULSION

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CONTENTS PAGE

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CHANGES IN THE RULES

General

This booklet is a reprint of the previous edition and apart from clarifications of text and the inclusion of amendments and corrections, published in the July 2002 edition of Pt.0 Ch.1 Sec.3, no other changes have been made.

This chapter is valid until superseded by a revised chapter.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 in Pt.0 Ch.1 Sec.1 to ensure that the chapter is current.

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SECTION 1
GENERAL REQUIREMENTS

A. Classification

A 100 Application

101 The rules in this chapter apply to vessels where the propulsion machinery, the steering gear and their auxiliary systems are built to give a fully redundant propulsion system and steering system.

102 The requirements of these rules are supplementary to the main class rules.

Guidance note:

In particular it is referred to relevant sections of:

Pt.3 Ch.3 Hull Equipment and Safety

Pt.4 Ch.2 Rotating Machinery, General

Pt.4 Ch.6 Piping Systems

Pt.4 Ch.8 Electrical Installations

Pt.4 Ch.9 Instrumentation and Automation

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A 200 Class notations

201 Vessels built and tested in compliance with the requirements of this document and the requirements of the main class rules may be assigned one of the following additional class notations:

RP - Redundant Propulsion

RPS - Redundant Propulsion and Separate.

202 Class notation **RP** is applicable to vessels where the propulsion system is of a redundant design such that at least 50% of the propulsion power can be restored after any single failure in the propulsion system, before the vessel has lost steering speed.

Guidance note:

Vessels designed and built with a larger degree of separation than 2 will be subject to special evaluation.

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203 Class notation **RPS** is applicable to vessels complying with 202, and in addition includes failures, which are caused by fire and flooding incidents, before the vessel has lost steering speed.

204 The propulsion system power capacity is to be such that the required remaining propulsion power, as recovered after any failure, will enable the vessel to maintain a speed of not less than 6 knots while heading into BF 8 weather conditions with corresponding wave conditions. The requirement is to be documented by computation where relevant wave spectrum is utilised.

Guidance note:

The time allowed for recovery of the propulsion power is linked to the steering capability with the object of allowing more time when the vessel is at transit speed in open waters than when the vessel is proceeding at reduced speed in congested waters or narrow passages, or is in a manoeuvring situation. This implies that systems which are not continually available should be prepared for service before entering critical situations where the recovery time otherwise would be too long in view of external hazards.

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205 The steering system is to be of redundant design, consisting of 2 rudders and steering gears, alternatively 2 azimuth thrusters, where each steering gear system is to be in compliance with the main class rules.

206 For both **RP** and **RPS**, the steering capability is to be available after any single failure. For **RPS** this includes incidents of fire and flooding in relevant areas.

207 For both **RP** and **RPS**, it is required that the vessel is to be able to proceed with the required remaining propulsion power for a period of at least 72 hours.

208 For vessels built for a specific service where the duration of a sea voyage is less than 72 hours, the built-in endurance at the required remaining propulsion power may be limited to the duration of the maximum crossing time but not less than 12 hours.

209 The vessel to be fully manoeuvrable when operating one (1) propulsion and one (1) steering system.

B. Documentation

B 100 Submission of plans and information

101 The propulsion and steering systems, with their auxiliaries, are to be documented according to main class requirements.

102 A Failure Mode and Effect Analysis, FMEA, for the complete propulsion and steering systems, with their auxiliaries, are to be submitted for approval. The FMEA is to show that redundancy requirements are fulfilled where relevant.

103 A test procedure for the final sea trial of the complete redundant propulsion and steering systems is to be submitted for approval.

C. Certification

C 100 General

101 All equipment is to be certified according to main class requirements.

D. Tests

D 100 Survey and test upon completion

101 For initial issue of class notation upon completion, the propulsion and steering systems, with their auxiliaries, are to be subjected to final tests during sea trials, in compliance with the requirements for main class.

102 Additional tests are to be carried out to verify the ability of the system to maintain the required remaining propulsion power.

103 Additional tests are to be carried out to verify the redundancy of the propulsion and steering system. The Failure Mode and Effect Analysis is to be used to determine the extent of such tests.

104 It is not required that the built-in endurance as required by A207 and A208 be demonstrated. However, time-critical resources are to be substantiated by adequate tests of rate of consumption and depletion.

105 The complete scope of testing is to be presented in a test program.

SECTION 2
SYSTEM DESIGN

A. General

A 100 Redundancy concept

101 The redundancy concept is to ensure the ability of the system to remain in operation, in accordance with the requirement in Sec.1 A207 or A208, with the defined propulsion and steering capacity after the occurrence of any single failure, as specified in 200.

A 200 Failure modes

201 For the **RP** notation, the defined failure modes include component breakdown and operational malfunctions, but excludes the effects of fire and flooding. Thus, it is acceptable that redundant components are installed in a common area or compartment.

Guidance note:

Main Class differentiates between active and passive components, and passive components are not required to be redundant. I.e., the reliability of passive components is assumed adequate to prevent component failures. This philosophy is also applied for these notations, but a number of components, which are normally considered to be passive are defined as active. E.g., all pumps, coolers, filters, and motorised valves are to be considered as active components. Fuel oil tanks are also considered to be active because the quality of their contents can deteriorate relatively rapidly.

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202 For the **RPS** notation, the failure modes include all those defined for **RP**, in addition to any failure in the propulsion and steering systems that will result from incidents of fire and flooding. Hence, redundant components and systems are to be located in different fire sub-divisions. These sub-divisions are, in addition, to be watertight below the damage waterline if above the freeboard deck, (see Pt.3 Ch.1 or Pt.3 Ch.2).

B. System Configuration

B 100 General

101 The basic requirement of maintaining at least 50 % of propulsion power may be realised by installation of two mutually independent propulsion systems of equal capacity.

Guidance note:

"At least 50% propulsion power" is to be understood as the nominal power consumption of one propeller when operating with all propulsion systems together. I.e. the deviations in thrust output caused by changes in vessel speed and propeller r.p.m. at loss of one propulsion system need not to be considered.

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Guidance note:

Typical configuration will consist of two propulsion lines, alternatively two azimuth thrusters. Two independent engine systems geared onto one propeller are not considered equivalent.

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102 The redundancy in steering function shall be realised by the installation of two mutually independent steering systems, each consisting of one rudder and steering gear. Alternatively, one azimuth thruster including its steering gear. Each system, with steering controls and actuators, is to comply with the main class rules for steering systems.

103 At maximum failure of one propulsion system, the steering capability, as required for main steering gear, is to be available at the maximum achievable speed. (See Pt.3 Ch.3).

104 Configurations consisting of more than two independent auxiliary systems are acceptable and may contain systems which are not in normal use, provided they maintain the required propulsion power in compliance with Sec.1 A202 and A203.

Guidance note:

Restoration of propulsion power within 30 minutes from dead ship condition as required by SOLAS will only be required to be implemented from one of the propulsion systems.

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B 200 Electrical power generation

201 For propulsion systems, where the propulsion power is produced directly by the main engines, the electrical power required for steering and auxiliary systems is to be generated by a power plant in compliance with main class and the redundancy requirements for the actual notation.

202 For electric propulsion systems, where the propulsion power is produced by generators, the electrical power required for steering and auxiliary systems may be produced by the same generators; distributed and integrated with the propulsion power system. Alternatively, the electrical power may be produced by generators in a separate power system in compliance with main class and the redundancy requirements for the actual notation.

203 The vessel is to be capable of operating with the emergency switchboard out of operation.

B 300 Electrical power distribution

301 When power for propulsion, steering and their auxiliaries is supplied from one switchboard, the bus-bars of the switchboard are to be arranged for automatic separation into at least 2 sections, with the circuits for propulsion and steering units and auxiliaries distributed between the sections. Automatic separation is to take place when short circuit currents are detected on the main bus-bars.

302 When the switchboard is divided into sections the auxiliary systems are to be arranged so that each of the propulsion and steering systems are capable of being operated independently of the other sections.

303 For **RPS** notation, the switchboard sections shall be separated by A-60 protection. These sections may be connected by 2 bus-tie breakers, which are to be installed at each side of the A-60 partition.

304 The power distribution system is to be arranged so that the power supply can be maintained or automatically restored, such that the power supply to the switchboard(s) is restored within 30 s and power to the auxiliary services in compliance with Sec.1 A202 and A203.

305 The steering function is to be maintained by emergency power upon loss of main power.

B 400 Electrical power plant control

401 The power plant control system is to be arranged so that a single failure therein will not jeopardise the propulsion redundancy concept.

402 Battery and UPS power sources are to be arranged in accordance with D300.

C. Auxiliary Systems

C 100 General

101 Active components as specified in Pt.4 Ch.1 Sec.3 B300 are to be arranged with redundancy in order that any one component may be taken out of service for maintenance purposes without having to reduce the normal full propulsion power.

Guidance note:

For definition of active components see Guidance note to A201 and Pt.4 Ch.1 Sec.3 B300.

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102 Fixed piping may be shared by redundant components for the **RP** notation, except as given in 201, 402 and 600.

103 For the **RPS** notation, separate piping systems are to be arranged for redundant systems. Cross-over pipes are accepted provided these can be closed from both sides of separating bulkheads, with one valve on each side of the bulkhead(s) fitted directly or as close as possible to it.

104 If equipment is dependent upon cooling , i.e. air ventilation or another cooling media, in order to avoid excessive heat increase, it is to be designed with redundancy.

105 For **RPS**, the capacity of the bilge system in each engine room is to be in accordance with the main class rules.

106 Main and emergency fire fighting systems are to be arranged in accordance with SOLAS requirements.

C 200 Fuel oil

201 There are to be at least two service tanks, which are to serve dedicated sub-systems. Cross-over facilities may be arranged, but are to be kept closed in normal operation.

202 For **RPS**, the service tanks are to be installed one in each of the separate engine rooms.

203 The transfer and fuel oil pre-treatment systems and tank arrangements shall be able to support the required remaining propulsion capacity in accordance with Sec.1 A207 or A208.

Guidance note:

Fuel pre-treatment is to be understood as all equipment for purification, filtering, heating, and measuring fuel oil.

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204 If the fuel system requires heating, the heating system is to comply with redundancy requirements

C 300 Lubrication oil system

301 Each propulsion system is to have an independent lubrication oil circulation system.

302 The lubrication oil storage and purification system is to be able to support the required remaining propulsion capacity in accordance with Sec.1 A207 or A208.

C 400 Cooling water

401 Cooling water systems for **RP** and **RPS** notations are to comply with main class rules, also taking into consideration the requirements for component redundancy given in A200.

402 Fresh water cooling systems are to be arranged with full separation between redundant systems, in view of the risk of severe loss of water or accumulation of gas due to leakage.

C 500 Compressed air system

501 The starting air system is to comply with main class for **RP**. For **RPS**, an equivalent system will be accepted when the compressors and air receivers are adequately distributed on both sides of fire and or flooding partitions.

502 The control air system is to be considered in view of the actual use of compressed air for control functions. If control air is found necessary for essential functions in the propulsion and steering system, full redundancy requirements will apply.

C 600 Ventilation systems

601 Ventilation systems are not to have any common units or cross-over pipes, when supplying different fire-division areas, which are required in order to comply with the **RPS**.

D. Propulsion, Steering and Auxiliary Control System

D 100 Propulsion control system

101 Independent control systems for each propulsion line are to be arranged according to main class and consistent with the failure concept given in A200. Each line is to include a main control station and an emergency control station.

102 Reliable means of communication, also operable during black-out, between the navigating bridge and the alternative control stations are to be arranged.

103 The bridge propulsion control system is to be independent for each propulsion line, so that any single failure will only affect one of them. If arranged with common parts, these are to be arranged with redundancy so that any single failure will not prevent continued normal control of the complete propulsion system.

Guidance note:

Mechanical levers are not required to be duplicated.

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104 At failure of control of one propulsion unit, this unit may be stopped, as an alternative to remain in operation at fixed thrust.

105 If a centralised control system is arranged for auxiliary systems, failure within this system is not to cause disruption of the total propulsion system. The portion affected is to be consistent with the redundancy concept for propulsion.

D 200 Battery and UPS power supply

201 Uninteruptible power supplies (UPSs) that provide power to the control system shall be built with redundancy in technical design and physical separation, and in addition, each be arranged with a by-pass, which may be used when an UPS fails. If the control system is powered by batteries, the batteries shall be built with redundancy in technical design and physical separation, and in addition, be arranged with cross-over facilities, which may be used when a battery fails.

202 Control power sources are to be selected and duplicated so that all equipment that has not lost the main power source due to a partial black-out can be operated.

D 300 Steering gear redundancy

301 The steering gear control system is to be redundant, consisting of two systems, in addition to the emergency steering, each in compliance with main class rules.

302 Failure of one steering gear control system is not to affect the other.

E. Separation Requirements for RPS

E 100 General

101 Redundant equipment is to be separated by bulkheads, which are to be fire insulated A-60 class division, and in addition are to be watertight if below the damage water line. Watertight bulkheads are to be strong enough to withstand one

sided flooding, and if doors are fitted in such bulkheads, they shall comply with SOLAS reg. II-1/25-9.

Guidance note:

Two A-0 bulkheads separated by a space (cofferdam, tank etc.) may be accepted as equivalent to A-60.

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102 Cabling to redundant equipment is not to run along the same route. When this is practically unavoidable, cables running together within an A-60 cable duct or equivalent fire protection, are accepted. This alternative is not accepted in high fire risk areas, e.g. engine rooms and fuel treatment rooms.

Guidance note:

If cables are located in A-60 cable ducts, means should be provided to keep the temperature inside the duct within the specified temperature for the cables.

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103 The control panels on the bridge are accepted as a non-separable and do not need to be separated by A-60 partitions provided alternative control stands are arranged.

104 Local control of propulsion and steering is to be possible according to main class requirements. Such means are to be operable after any failure of the central bridge installation by reliable means of separation of remote and local control.