



# RULES FOR CLASSIFICATION OF **SHIPS**

## NEWBUILDINGS

SPECIAL EQUIPMENT AND SYSTEMS  
ADDITIONAL CLASS

### PART 6 CHAPTER 2

## REDUNDANT PROPULSION

JANUARY 2003

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

### CONTENTS

### PAGE

Sec. 1	General Requirements .....	5
Sec. 2	System Design .....	6

DET NORSKE VERITAS

Veritasveien 1, NO-1322 Høvik, Norway Tel.: +47 67 57 99 00 Fax: +47 67 57 99 11

# 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This chapter is valid until superseded by a revised chapter.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.

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

For subscription orders or information about subscription terms, please use [distribution@dnv.com](mailto:distribution@dnv.com)

Comprehensive information about DNV and the Society's services is found at the Web site <http://www.dnv.com>

© Det Norske Veritas

Computer Typesetting (Adobe FrameMaker) by Det Norske Veritas

Printed in Norway

If any person suffers loss or damage which is proved to have been caused by any negligent act or omission of Det Norske Veritas, then Det Norske Veritas shall pay compensation to such person for his proved direct loss or damage. However, the compensation shall not exceed an amount equal to ten times the fee charged for the service in question, provided that the maximum compensation shall never exceed USD 2 million.

In this provision "Det Norske Veritas" shall mean the Foundation Det Norske Veritas as well as all its subsidiaries, directors, officers, employees, agents and any other acting on behalf of Det Norske Veritas.

## CONTENTS

<b>SEC. 1 GENERAL REQUIREMENTS .....</b>	<b>5</b>	<b>B. System Configuration .....</b>	<b>6</b>
<b>A. Classification.....</b>	<b>5</b>	B 100 General .....	6
A 100 Application.....	5	B 200 Electrical power generation .....	6
A 200 Class notations .....	5	B 300 Electrical power distribution.....	6
		B 400 Electrical power plant control .....	6
<b>B. Documentation .....</b>	<b>5</b>	<b>C. Auxiliary Systems.....</b>	<b>7</b>
B 100 Submission of plans and information .....	5	C 100 General .....	7
		C 200 Fuel oil .....	7
<b>C. Certification.....</b>	<b>5</b>	C 300 Lubrication oil system.....	7
C 100 General .....	5	C 400 Cooling water.....	7
		C 500 Compressed air system .....	7
<b>D. Tests.....</b>	<b>5</b>	C 600 Ventilation systems .....	7
D 100 Survey and test upon completion .....	5	<b>D. Propulsion, Steering and Auxiliary Control System.....</b>	<b>7</b>
<b>SEC. 2 SYSTEM DESIGN .....</b>	<b>6</b>	D 100 Propulsion control system.....	7
<b>A. General.....</b>	<b>6</b>	D 200 Battery and UPS power supply .....	7
A 100 Redundancy concept .....	6	D 300 Steering gear redundancy.....	7
A 200 Failure modes.....	6	<b>E. Separation Requirements for RPS .....</b>	<b>7</b>
		E 100 General .....	7



## 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

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

#### 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.

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

**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 shall 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 shall 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.

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

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

**206** For both **RP** and **RPS**, the steering capability shall 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 shall 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, shall 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, shall be submitted for approval. The FMEA shall 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 shall be submitted for approval.

### C. Certification

#### C 100 General

**101** All equipment shall 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, shall be subjected to final tests during sea trials, in compliance with the requirements for main class.

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

**103** Additional tests shall be carried out to verify the redundancy of the propulsion and steering system. The Failure Mode and Effect Analysis shall 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 shall be substantiated by adequate tests of rate of consumption and depletion.

**105** The complete scope of testing shall be presented in a test program.

## SECTION 2 SYSTEM DESIGN

### A. General

#### A 100 Redundancy concept

**101** The redundancy concept shall 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 shall be considered as active components. Fuel oil tanks are also considered to be active because the quality of their contents can deteriorate relatively rapidly.

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

**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 shall 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” shall 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.

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

##### 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.

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

**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, shall 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, shall 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.

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

#### 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 shall 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 shall 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 shall 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 shall take place when short circuit currents are detected on the main bus-bars.

**302** When the switchboard is divided into sections the auxiliary systems shall 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 shall be installed at each side of the A-60 partition.

**304** The power distribution system shall 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 shall be maintained by emergency power upon loss of main power.

#### B 400 Electrical power plant control

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

**402** Battery and UPS power sources shall 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 shall 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.

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

**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 shall 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 shall be designed with redundancy.

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

**106** Main and emergency fire fighting systems shall be arranged in accordance with SOLAS requirements.

### C 200 Fuel oil

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

**202** For **RPS**, the service tanks shall 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 shall be understood as all equipment for purification, filtering, heating, and measuring fuel oil.

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

**204** If the fuel system requires heating, the heating system shall comply with redundancy requirements

### C 300 Lubrication oil system

**301** Each propulsion system shall have an independent lubrication oil circulation system.

**302** The lubrication oil storage and purification system shall 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 shall comply with main class rules, while also taking into consideration the requirements for component redundancy as given in A200.

For vessels with class notation **Passenger ship** or **Ferry** notation, sea water suction shall be arranged from separate sea chests located in the bottom of the ship, in addition to a high sea chest located at one side.

The two low sea chests shall have separate ventilation arrangements.

**402** Fresh water cooling systems shall 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 shall 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 shall 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 shall not 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 shall be arranged according to main class and consistent with the failure concept given in A200. Each line shall 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 shall be arranged.

**103** The bridge propulsion control system shall be independent for each propulsion line, so that any single failure will only affect one of them. If arranged with common parts, these shall 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.

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

**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 shall not cause disruption of the total propulsion system. The portion affected shall be consistent with the redundancy concept for propulsion.

### D 200 Battery and UPS power supply

**201** Uninterruptible 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 shall 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 shall 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 shall not affect the other.

## E. Separation Requirements for RPS

### E 100 General

**101** Redundant equipment shall be separated by bulkheads, which shall be fire insulated A-60 class division, and in addition shall be watertight if below the damage water line. Watertight bulkheads shall be strong enough to withstand one sided flooding, and if doors are fitted in such bulkheads, they shall comply with SOLAS Ch. 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.

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

**102** Cabling to redundant equipment shall not run along the same route. When this is practically unavoidable, cables run-

ning 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.

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

**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 shall be possible according to main class requirements. Such means shall be operable after any failure of the central bridge installation by reliable means of separation of remote and local control.