TÜRK LOYDU

Chapter 23 - Redundant Propulsion and Steering Systems

January 2023

This latest edition incorporates all rule changes. The latest revisions are shown with a vertical line. The section title is framed if the section is revised completely. Changes after the publication of the rule are written in red colour.

Unless otherwise specified, these Rules apply to ships for which the date of contract for construction as defined in TL- PR 29 is on or after 1st of January 2023. New rules or amendments entering into force after the date of contract for construction are to be applied if required by those rules. See Rule Change Notices on TL website for details.

"General Terms and Conditions" of the respective latest edition will be applicable (see Rules for Classification and Surveys).

If there is a difference between the rules in English and in Turkish, the rule in English is to be considered as valid. This publication is available in print and electronic pdf version. Once downloaded, this document will become UNCONTROLLED. Please check the website below for the valid version.

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SECTION 1

GENERAL RULES AND INSTRUCTIONS

A. General

1. The Rules relating to redundant propulsion and steering systems apply to ships, which are classified by **TL** and are to receive the notation RP 1x%, RP2x% or RP3x% affixed to the character of classification.

2. The RP class notation set forth the rules in order to ensure that the propulsion and steering systems will remain in operation, or be restored to a certain degree, after a single failure. The number besides the RP notations determines the level of system redundancy. The suffix x represents the remaining power capacity after failure.

3. These Rules apply in addition to the following TL's Rules for Classification of steel ships, in particular.

– Chapter 1, Hull,

– Chapter 4, Machinery,

– Chapter 4-1, Automation,

– Chapter 5, Electric.

4. The scope of the additional RP notation ensures a higher level of safety due to increasing the availability of propulsion and steering capabilities. Afterward a single failure, the design shall make certain that the propulsion and steering systems will remain in operation, or be restored to a certain degree. The propulsion and steering systems arrangement shall be evaluated by means of FMEA methods. The requirements of the rules in this section are supplementary to the main class rules therefor the additional class notation RP does not include the requirements or recommendations concerning the vessel's operation or other characteristics.

B. Definitions

These Rules are subject to the following definitions:

Single-failure concept:

The basis of the single-failure concept within the context of these Rules is: With regard to a possible loss of propulsion or steering capability of the ship, only one single failure (initiating event) is acceptable at any given time. The simultaneous occurrence of unrelated failures is excluded. Exception to this rule is the common occurrence of failures, if they arise as an inevitable consequence of a single primary failure.

Propulsion system:

A system, which provides thrust to propel the ship. It consists of propulsion machines and the auxiliary systems needed to operate them, all the equipment to transmit propulsion power into thrust and all the requisite monitoring and control systems, alarm and safety systems.

Steering systems:

A system for controlling the course of the ship. It consists of the rudder, the rudderstock and the steering gear together with all the requisite monitoring and control systems, alarm and safety systems.

Azimuth propulsion system:

A combined system for steering the ship and provision of propulsion power. Podded drives, rudder propellers, rotatable waterjets and cycloid propellers are regarded as azimuth propulsion systems within the context of these Rules.

The requirements stated in these Rules are based on system configurations with a conventional shaft propulsion system for providing propulsion and with a steering system for controlling the ship's course.

In the case of azimuth propulsion systems, the requirements relating to propulsion systems and steering systems apply in an analogous manner unless other requirements specific to azimuth propulsion systems are explicitly specified.

Main propulsion power:

The total power provided by the prime movers installed to provide propulsion. Unless otherwise specified, this does not include the power provided by propulsion units, which can be switched on when required but are not intended to provide propulsion during normal operation, e.g. shaft-driven generators in power take-in mode or additional waterjet propulsion units.

Level of redundancy:

The classification of mechanical, electrical and spatial separation and also the independence of the systems required for propulsion and steering. The redundant propulsion power of the propulsion system is denoted by the additional index x%.

Example: The additional index 40% means, that following a failure of one of the redundant propulsion systems, at least 40% of the main propulsion power will still be available.

C. Documents to be Submitted

1. Compliance with the requirements set out in Section 3, in accordance with the notation applied for, must be demonstrated by block diagrams, schematic drawings, descriptions of system functions and operation, calculations and arrangement plans.

Model tests or calculations shall be used to show the speed and manoeuvring qualities that have to be attained during sea trials.

2. A failure mode and effects analysis (FMEA) or an equivalent analysis must be conducted for the propulsion and steering systems, and for the auxiliary systems needed to operate them.

The analysis must demonstrate that a single failure cannot lead to any loss in propulsion and/or in steering ability.

The analysis shall further demonstrate that measures are in place for failure detection and control of possible effects and that these measures are adequate to ensure in particular that the propulsion and steering of the ship can be rapidly restored.

In addition, the analysis must deal with the identification of possible failure conditions, which have a common cause. The identification of technical elements and/or operational procedures, which could undermine the redundancy concept, must also be accounted for.

For the notation RP1x%, the FMEA only has to be performed for the redundant propulsion machines and their requisite auxiliary systems. The events of water ingress or fire in a machinery compartment, and a failure of any of the common elements of the propulsion train, do not have to be considered.

For the notation RP2x% the F M EA has to be performed for the redundant propulsion and steering systems. The events of water ingress or fire in a machinery compartment and water ingress in a steering gear compartment do not have to be considered.

For the notation RP3x% arrangement: the FMEA has to be performed for the redundant propulsion and steering systems. The events of water ingress or fire are to be considered.

3. For each notation (RP1-3x%), related specific requirements are to be provided in the submitted documentation. e.g. indication of the fire zones for installation of redundant equipment and cable routings for all relevant cables for all systems required to restore and maintain propulsion and steering for RP3x%.

4. A programme of tests to be conducted during sea trials must be submitted for approval.

SECTION 2

CLASSIFICATION NOTATIONS

A. General

Vessels built and tested in compliance with the requirements of this section, additional class notation RP (together with suffixes "x") may be assigned, as given in B.

For example:

- RP1x% can be assigned to ships which has propulsion systems arrangement where main and alternative propulsion are provided by a common propulsion system with redundant prime movers,

- RP2x% can be assigned to ships which has propulsion system arrangement of two propulsion systems operating in parallel and,

- RP3x% can be assigned to ships, which has two propulsion system which are installed in each hull of catamarans or separated by watertight A-60 bulkheads and operating in parallel.

The suffix "x" indicates that min. percentage of the propulsion power can be restored and maintained subsequent to single failure.

B. RP Class Notations

1. RP1x%

Main and alternative propulsion is provided by a common propulsion system with redundant prime movers or by separate propulsors that can restore and maintain at least x% of propulsion power following a single failure. e.g.:

- Two prime movers with clutches, one shaft line, and one rudder, one of which may be a power take in type.

- The main propulsion system consists of one prime mover, one shaft line, and one rudder, together with a separate alternative propulsion system, such as an azimuth or pod thruster, capable of providing manoeuvrability.

See Figure 2.1a and 2.1b.

Note: *A retractable type azimuth thruster can be accepted as alternative propulsion.*

2. RP2x%

The vessel propulsion and steering system is of to be a redundant design with two (or more) propellers in parallel operation such that at least x% propulsion power are available and associated steering system can be restored and maintained after single component failure.

See Figure 2.2a and 2.2b

3. RP3x%

The vessel propulsion and steering system is of a redundant design with two (or more) propellers operating in parallel and separated by a watertight and A-60 class fire rated bulkheads, such that at least x % propulsion power are available and associated steering system can be restored and maintained after single component failure and upon incidents of fire or flooding.

See Figure 2.3a and 2.3b.

SM : Propulsion Machine
AP : Alternative Propulsion
D : Gear Box
SJ : Water Jet
MSB : Main Switchboard

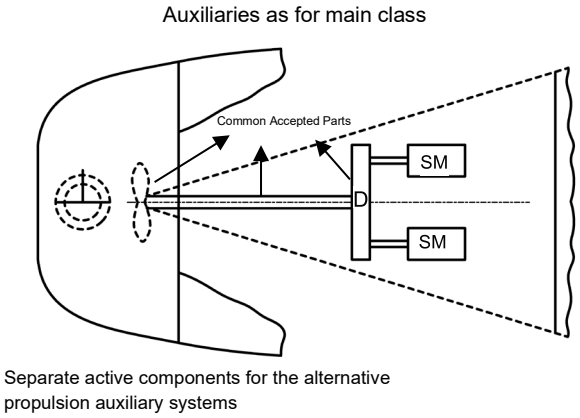

Figure 2.1a Example RP1x%

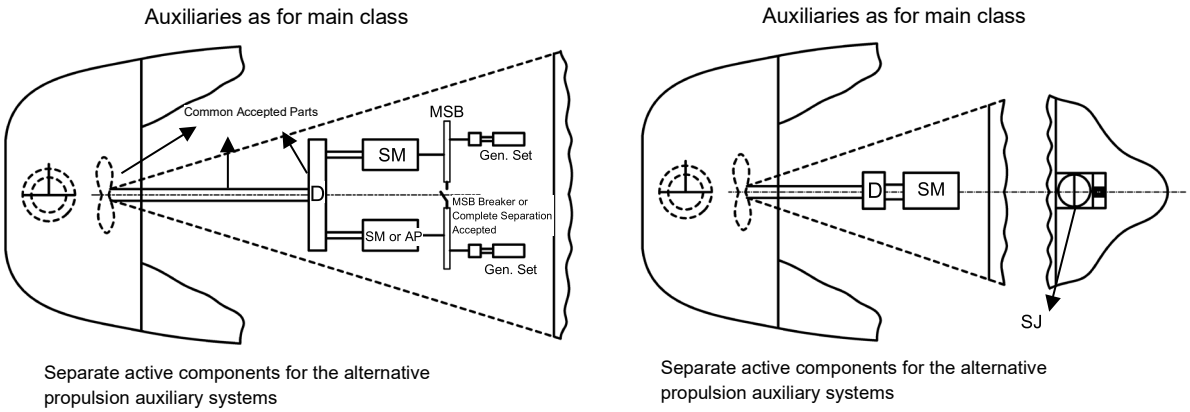

Figure 2.1b Examples RP1x%

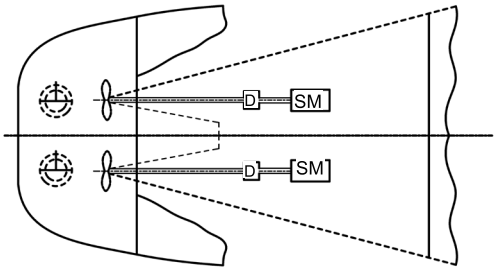

Figure 2.2a Example RP2x%

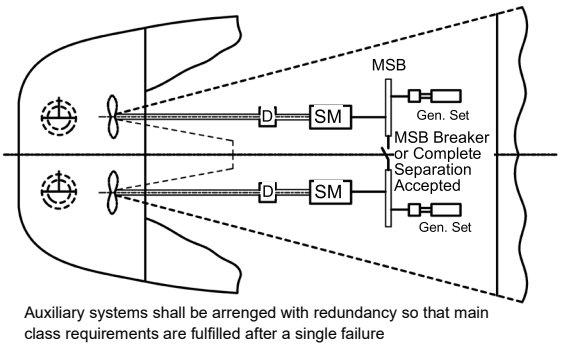

Figure 2.2b Example RP2x%

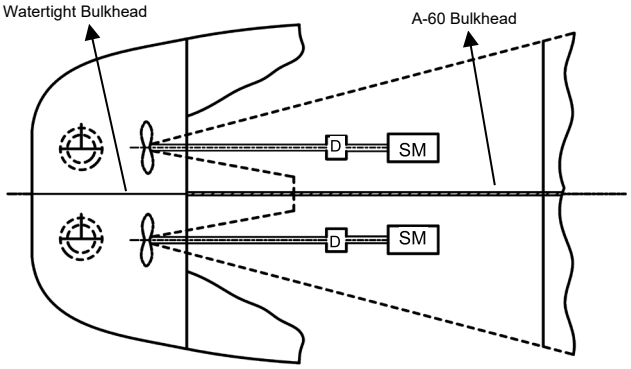

Figure 2.3a Example RP3x%

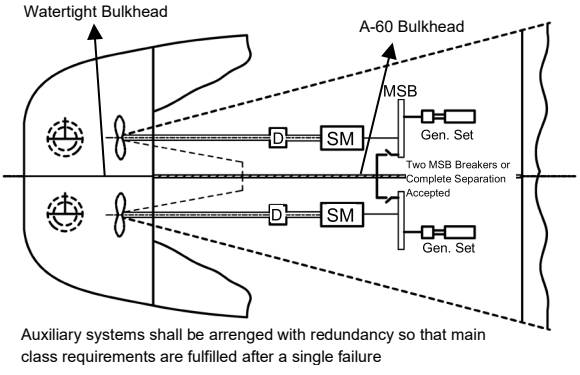

Figure 2.3b Example RP3x%

SECTION 3

REQUIREMENTS

A. Requirements for the class notation RP1x%

1. General

1.1 Basic requirements

1.1.1 The design shall ensure that the main or alternate propulsion system can be brought to and maintained in operation once a single failure occurs.

1.1.2 The alternative propulsion shall be designed for continuous operation.

Note: *In general, there should be no restrictions on the starting intervals of electrical machines. In case of any restriction arranged, then the arrangement is subject to approval in each case.*

1.1.3 The power capacity of the alternative propulsion system should be sufficient to enable the vessel to maintain a speed of at least 7 knots.

1.1.4 The vessel shall be able to navigate for at least 72 hours by the propulsion power specified in 1.1.3. For vessels designed for a specific service area where the navigation time is less than 72 hours, the built-in endurance of the alternative propulsion system may be limited to the duration of the maximum navigation time, but not less than 12 hours.

Note: *This limitation will be specified in the appendix to the classification certificate if a vessel is built to operate with an alternative propulsion system for less than 72 hours.*

1.1.5 Except for failure in common active and passive components where common components have been found acceptable, the alternative propulsion system is required to be activated within 30 minutes of the main propulsion system failure.

Note: *Manual mechanical work may be required to activate the alternative propulsion system, provided that all necessary procedures and equipment are kept on board the vessel and that activation of the alternative propulsion (with the required capacity) within 30 minutes can be demonstrated during sea trials.*

1.2 Failure modes

Failures of any active component or system are included in the defined failure modes, with the exception of failures in common active components that are specially accepted as common. This includes normally propeller, shaft and gear for the arrangement of one propeller shaft train with two driving units acting via the common gear box.

2. Arrangement

2.1 General

The basic requirements in order to providing the alternative propulsion power are as described in 1.1.

2.2 Electrical power distribution

The power distribution to both the main and alternative propulsion systems, as well as their respective auxiliary systems,

shall be arranged so that at least one of the propulsion systems to be capable of being put into operation and operated after loss of any single switchboard section.

2.3 Electrical power plant control

The power plant control system shall be arranged so that a single failure shall not be damaging to both main and alternative propulsion.

3. Auxiliary Systems

3.1 Auxiliary systems for redundant propulsion systems whose function have a direct effect on the propulsion system, for example fuel, lubrication oil, control air and uninterrupted power supply systems, must be provided for each propulsion system independently of each other.

Where standby units are specified for these systems in accordance with **TL** rules, these must be provided for each of the systems in question.

3.2 Fuel oil system

3.2.1 The transfer and fuel oil pre-treatment systems and tank arrangements shall be able to support the power capacity required by 1.1.3 for the period specified in 1.1.4 after a single failure as specified in 1.2, unless fuel which do not require pre-treatment are arranged for the period.

All equipment for purification, filtering, heating, and measuring fuel oil is referred to as fuel pre-treatment.

3.3 Lubrication oil system

3.3.1 Lubrication oil systems for the main propulsion system and the alternative propulsion system should be independent.

3.3.2 After a single failure as indicated in 1.2, the lubricating oil storage and purification system must be capable of supporting the power capacity required by 1.1.3 for the period specified in 1.1.4.

3.4 Compressed air system

3.4.1 The starting air system shall comply with main class for the main propulsion, and with adequate facilities to enable three starting attempts for the alternative propulsion

4. Propulsion and Manoeuvring Control Systems

4.1 General

4.1.1 When a centralized control system is arranged, the control system arrangement shall comply with the requirements for redundancy and separation as given by these rules.

4.2 Propulsion control system

4.2.1 Independent local control for main and alternative propulsion system must be designed up in accordance with the failure concept given in 1.1.1. Each system must have its own control panel. Such systems shall be in operable condition

after in the event that the centralized control system installed on the navigational bridge fails.

4.2.2 For both main and alternative propulsion, reliable means of communication between the navigation bridge and the emergency/local control stations shall also operable during black-out.

4.2.3 On the navigational bridge, remote control of both the main and alternate propulsion systems shall be installed. The main and alternate remote propulsion control systems on the navigational bridge shall be independent of each other, so that a single failure will only affect one of them.

Note: *There is no obligation to apply the redundancy requirements to the mechanical levers.*

4.3 Sources of control power

4.3.1 The power supply for the main and alternative propulsion and steering systems shall be distributed in compliance with requirement 1.1.1 for redundancy.

4.4 Manoeuvring control system

4.4.1 If a second driving unit, such as an independent steerable thruster or a water jet, provides alternative propulsion and manoeuvring:

a) Steering systems belongs to main and alternative propulsion, shall be independent.

b) For The steering system of alternative propulsion, must have the same strength and capacity of the corresponding main system's at maximum speed (minimum 7 knots). An auxiliary steering gear is not required for the alternative propulsion steering systems.

B. Requirements for the Class Notation RP2x% and RP3x%

1. System Design

1.1 Redundancy concept

1.1.1 The redundancy concept shall ensure that the system can be restored and/or remain operational in accordance with the specific redundancy notation's objectives. This includes the following aspects:

- Propulsion
- Steering
- Recovery time
- Endurance.

1.1.2 The propulsion system designed for the required redundancy shall be aimed to provide propulsion during normal operation.

1.1.3 For the RP2x % notation, the vessel's propulsion system should be designed in such a way that at least x % of propulsion power can be restored following a single failure in the propulsion and auxiliary systems, before the vessel loses steering speed.

1.1.4 For the RP3x% notation, the requirement to ensure at least x% of the propulsion power as indicated in 1.1.3 also includes single failure of one compartment caused by fire and flooding incidents.

1.1.5 The remaining propulsion power capacity (as indicated in 1.1.3) shall enable the ship to maintain a speed of at least 6 knots while heading into BF 8 weather conditions with corresponding wave conditions. The requirement shall be documented by computation using the appropriate wave spectrum.

Note: *The propulsion power capacity after a failure should be sufficient to keep the vessel and equipment in a safe condition for vessels participating in specialized operations, such as seismic, pipe layers, vessels in limited waterways, and so on. Based on the vessel's activities, this should be decided in collaboration with the shipowner. Written confirmation of the propulsion capabilities needs to be provided from the owner.*

1.1.6 Steering

The installation of two mutually independent steering systems, such as two rudders or two azimuth thrusters, will provide redundancy in the steering function.

Note: *Vessels with more than two propulsion and/or steering systems will be subject to special consideration.*

1.1.7 When only one propulsion system and one steering system are used, the vessel should be fully maneuverable.

Note: *This means that each steering system must meet the main class requirements for rudder capacity.*

1.1.8 Endurance

After any single failure, the vessel shall be able to navigate for a period at least 72 hours using the remaining propulsion power.

1.1.9 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 for vessels built for a specific service where the duration of a sea voyage is less than 72 hours..

Note: *Based on the vessel's operation area, the propulsion power period following failure should be decided in agreement with the ship owner. A document of written acceptance of the propulsion capabilities shall be submitted by the owner.*

1.2 Failure modes

1.2.1 The defined failure modes for the RP2x % notation include component breakdown and malfunctions, but exclude the effects of fire and flooding. Thus, redundant components arranged in a common area or compartment are acceptable.

1.2.2 The failure of the following components, shall be included in the component breakdown.

- Coolers and heat exchangers

- Filters
- Motorised valves
- Boilers
- Transformers
- Switchgear
- Cables
- Systematic failures or faults that's unidentified until a new fault occurs.

1.2.3 The failure modes for the RP3x % notation include all of those defined for the RP2x % notation, in addition to any failure in the propulsion and steering systems caused by fire or flooding. Hence, redundant components and systems shall be located in separate fire subdivisions. Below the bulkhead deck, the subdivisions shall be watertight. Separation requirements specified in C are also shall be taken into account.

Note:*The loss of stability (due to flooded compartments) is not a relevant failure mode.*

2. Arrangement

2.1 General

2.1.1 Installation of at least two mutually independent propulsion systems is required to fulfill the basic requirement of maintaining at least x % of propulsion MCR power.

Note: *The minimum of x% propulsion power shall be understood as the nominal power consumption of one propeller while operating with all propulsion systems together. I.e deviations in thrust output due to changes in vessel speed and propeller rpm resulting in a loss of one propulsion system do not need to be taken into account.*

2.1.2 Two propulsion (line) systems, or two azimuth thrusters, will be arranged in a typical configuration. The normal operation mode is to run two systems in parallel, with one system continuing to run in the event of a failure. Two separate engine systems geared to a single propeller shall not to be accepted as equivalent.

2.1.3 When ship steering (as required by 1.1.6) is based on design of the rudder's, each rudder's steering system, including its steering control and actuators, shall comply with the main class requirements. This means that each steering system shall be provided with a main- and auxiliary steering gear.

Note: *In case of a typical installation with two independent (i.e. main and auxiliary) steering gear systems for each rudder, one pump in each system is fed from the emergency switchboard and the two other pumps (one in each system) are fed from each side of the main switchboard.*

In such an arrangement one single failure may initially cause stop of three pumps.

2.1.4 When ship steering (as required by 1.1.6) is based on azimuth thrusters, the steering system for each thruster, including its steering controls and power actuators, shall be redundant. Each power actuator should have its own power supply.

Guidance note: This means that each steering system has a single failure tolerance towards that is failures in electrical components, control system units, control system power, cabling, signalling, and communication buses, and hydraulic pipe rupture.

2.1.5 If separate input devices (e.g. levers) are arranged for the redundant steering control of each thruster, the input devices shall be of similar design with similar operator interaction. If the signals to the two control units are electrically separated, a single input device may be accepted.

2.1.6 When one of the propulsion systems fails, the steering capability necessary for main steering gear shall be available at the maximum achievable speed.

2.2 Electrical power generation

2.2.1 The electrical power required for propulsion, steering, and auxiliary systems shall be generated by a power plant that meets the main class requirements and the redundancy, capacity, separation, and single failure integrity as defined for the targeted notation.

2.2.2 The vessel must be able to operate even if the emergency switchboard out of operation.

2.3 Electrical power distribution

2.3.1 When power for propulsion, steering and their auxiliaries is supplied from one switchboard, the busbars 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. When short circuit currents are detected on the main bus-bars, automatic separation shall be carried out. The bus-bar breaker(s) or interconnector breaker(s) shall be capable of breaking the system's maximum short circuit current and enable short circuit discrimination towards the generator breakers. Undervoltage trip shall be supplied in addition to the bus-bar breaker(s) or interconnection breaker(s). As an alternative the redundancy may be achieved by two independent switchboards.

2.3.2 The power supplying the control and auxiliary systems shall be so designed in such a way that at least one of the propulsion and steering systems are capable of being operated after failure of any one switchboard section. The remaining capacity shall comply with the capacity requirements in 1.1. This applies for both AC and DC electrical distribution systems.

2.3.3 While considering the single faults of the boards, the possibility of a short circuit of the busbars will be taken into account.

2.3.4 Control and protection systems of bus-bar's shall be designed to work with both open and closed bus-bar breakers.

2.3.5 For RP3x% notation, the switchboard sections as described in 2.3.1 shall be separated by bulkheads and decks whice are fire-insulated by A-60 class division. These bulkheads shall be watertight type, if their locations are below the bulkhead deck. Two bus-bar breakers, one on either side of the A-60 division, should be required to connect these sections. Separation requirements in C must also be complied with regarding power distribution.

2.3.6 The power distribution system shall be arranged so that the power supply can be automatically restored, such that the power supply to the switchboard(s) is restored within 45 seconds and power to the auxiliary services in compliance with 1.1.

3. Auxiliary Systems

3.1 General

3.1.1 Auxiliary systems shall be designed and separated in such a way that, in the event of a failure, they can support the required remaining propulsion and steering capacity in accordance with 1.1.

Note: *Typical systems including:*

- *Ventilation systems*
- *Cooling systems*
- *Fuel oil transfer system*
- *Fuel pre-treatment systems, i.e. all equipment for purification, filtering, heating, and measuring fuel oil*
- *Lubrication oil systems*
- *Other systems when relevant.*

3.1.2 In addition to the redundancy and separation required by 3.1.1, each auxiliary system shall be designed so that, in the event of the loss of any active component, the remaining system can maintain full propulsion power.

3.1.3 Except as specified in 3.2.1,.3.4.2, 3.5.2, and 3.6, fixed piping can be shared by redundant components for the RP2x % notation.

3.1.4 Separate piping systems shall be arranged for redundant systems when intended to have RP3x% redundancy notation. A-60 class fire division shall be used in order to separate these 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. Use of crossover valves shall be easy to reach and clearly marked. Ventilation ducts shall not have cross-over facilities.

3.1.5 In case of the equipment needs on air ventilation or another cooling media to control the ambient temperature, the cooling system shall be designed with redundancy too, in order to prevent excessive heat increase.

3.1.6 The capacity of the bilge system in each engine room shall comply with the main class rules when ship has redundancy notation RP3x %.

3.1.7 The main and emergency firefighting systems shall be arranged in compliance with the requirements of SOLAS Ch.II-2.

3.2 Fuel oil system

3.2.1 Minimum two service tanks are required to serve dedicated sub-systems. It is permissible to arrange cross-over facilities.

3.2.2 The service tanks and associated piping when ship has redundancy notation RP3x % must be installed one in each of the separated engine rooms.

3.2.3 In case of the fuel system needs heating, the heating system must also comply with the redundancy requirements as well as the separation requirements for the RP3x % redundancy notation.

3.3 Lubrication oil system

3.3.1 An independent lubrication oil circulation system is required for each propulsion system. The system shall comply with the general redundancy requirements and together with the separation requirements as applicable for the RP3x% notation.

3.4 Cooling water systems

3.4.1 Cooling water systems for RP2x % and RP3x % redundancy notations shall comply with the main class rules while also fulfill the component redundancy and separation requirements given in sections 1.2 and C below. Sea water suctions shall be supplied from separate sea chests located in the bottom of the ship, in addition to a high sea chest located on one side, if vessels have the class notation Passenger ship or Ferry. Separate ventilation system to be arranged for both two low sea chest.

3.4.2 Due to the risk of severe water loss or gas accumulation due to leakage, fresh water cooling systems must be set up as fully separated systems for the RP2x % notation, so that the redundancy and capacity requirements in 4.3 are fulfilled if one of the fresh water cooling systems fails.

Note: *When ship has notation RP2x %, redundant air conditioning and control of ambient temperature systems, such as air conditioning units, chillers, and HVAC, may share common piping.*

3.5 Compressed air system

3.5.1 For RP2x %, the starting air system shall comply with main class. When the compressors and air receivers are adequately distributed on both sides of fire and or flooding partitions, an equivalent system will be accepted for RP3x %.

3.5.2 The control air system shall be considered in view of the actual use of compressed air for control functions. Separated systems shall be arranged for the RP2x % notation if control air is found to be necessary for essential functions in the propulsion and steering system, so that the redundancy and capacity requirements in 4.2 are fulfilled after failure of any one control air system.

3.6 Ventilation systems

3.6.1 When supplying different fire-division areas, ventilation systems must not have any common units or cross-over pipes when ship has RP3x % notation.

4. Propulsion, Manoeuvring and Auxiliary Control System

4.1 Propulsion control system

4.1.1 Each propulsion line's independent control systems must be arranged by main class and in compliance with the failure concept described in 1.2. A main and an emergency control station are to be provided on each line.

4.1.2 Between the navigation bridge and the alternative or emergency control stations, a reliable means of communication shall be arranged, which it is operable during a blackout.

Note: *When ship has notation RP3x %, this requirement shall not be applied to failure modes which make the bridge unavailable, such as fire.*

4.1.3 The bridge propulsion control system shall be independent for each propulsion line; so that any single failure will only affect one of them, and that operation of the remaining system can continue on the normal means of operation (e.g. levers). Alternatively, (in addition to the independent back-up control system for each propulsion system) if a system arranged with redundancy is arranged, can be acceptable. The redundant system shall be so designed up in such a way that a single failure will not prevent normal complete control propulsion system from continuing. The independent back-up control system shall be based upon similar input devices as the normal means of operation (e.g. levers).

4.1.4 Local control shall be available for both propulsion systems in the event of a single failure of cabling or equipment on the bridge or between the bridge and the location where the local control is installed. When ship has RP3x % notation this also includes fire incidents, and associated cabling and equipment installed outside of the bridge shall comply with the requirements in C below.

4.1.5 Both normal bridge control and backup control,if arranged according to 4.1.3, shall be arranged so that the operator can control the systems from (or close to) the main navigation stand, allowing the operator to maintain a normal view of the outside and the required feedback and heading indicators.

Note: *There is no obligation to apply the redundancy requirements to the mechanical levers.*

4.2 Control system for auxiliary services

4.2.1 Control systems for auxiliary systems shall be configured in accordance with the propulsion and steering redundancy and separation concept, so that a single failure within any control system does not affect the required remaining propulsion and steering capabilities, as specified in the specific notations.

4.3 Battery and UPS systems

4.3.1 If control systems are supplied by uninterruptible power supplies (UPSs), the UPSs must be configured with redundancy in technical design and physical separation, as well as a by-pass that may be used in the event that one of the UPSs fails. The redundant UPS's input power supply for different redundancy groups must be obtained from relevant sides of the main switchboard. Each UPS's battery shall be capable of providing output power for min 30 minutes at maximum load.

4.3.2 If the control system is powered by batteries, the batteries shall be designed with redundancy in terms of technical design and physical seperation, as well as cross-over facilities in case a battery fails. The battery installed shall be capable of providing output power for min 30 minutes at maximum load.

4.3.3 An alarm at the navigating bridge will be activated in case the UPS charge fails or the UPS by-pass is occured.

4.3.4 An audible and visual alarm will be initiated on the navigational bridge in the following circumstances;

- Power supply failure
- Earth fault,
- Operation of the battery protection device,

- While the battery is discharging and

- For online UPS units when the bypass is in operation.

4.3.5 Control systems' power shall be designed such that any equipment that should not lost power due to a partial blackout and can continue to operation.

4.4 Steering control system

4.4.1 The requirements in 4.1.4 and 4.1.5 are also to be applied to the bridge steering gear systems as well.

C. Compartment Separation Requirements for the class notation RP3x%

1. General

1.1 Systems, including single components, cabling, and piping that are part of the designed redundancy, shall be separated by A-60 class division bulkheads and decks and these divisions shall be watertight construction if located below the bulkhead deck. Watertight bulkheads shall be able to withstand one-sided flooding and when watertight doors are exist on it they shall comply with SOLAS Ch. II-1 Reg-13.

Note 1: *If two A-0 bulkheads with min 600 mm. spacing are arranged in areas with low fire risk, this may be accepted based on case-by-case approval.*

Note 2: *When complying with the above requirement is unpracticable, cables running together within an A-60 cable duct or comparable fire-protection can be acceptable. In high fire risk areas, such as engine rooms and fuel treatment rooms, this alternative is not acceptable. In such ducts, cable connection boxes are not permitted. If A-60 cable ducts are used while intallation of cables, provisions should be made to keep the temperature inside the duct within the specified temperature for the cables. Above mentioned measures applies to piping as far as practicable..*

Note 3: *Refer to Machinery Spaces Category A, defined in SOLAS Chapter II-2 Reg 3.31 for high fire risk areas.*

1.2 The remote control panels and cabling on the bridge area are considered non-separable and no need the use of A-60 partitions to separate them if alternate control stands are arranged.

SECTION 4

TRIALS

A. Requirements

Tests are to be performed during sea trials in accordance with an approved sea trials programme. The tests are designed to prove that.

– The ship is able to meet the requirements set out in Section 3;

– The propulsion and steering systems have the necessary redundancy in line with the notation applied for;

– The conclusions drawn in the F M EA regarding the effects of failure conditions and measures to detect and control these failure conditions are correct and adequate.