BUREAU VERITAS MARINE & OFFSHORE

RULES FOR CLASSIFICATION

RULES FOR THE CLASSIFICATION OF **NAVAL SHIPS**

PART E

ADDITIONAL CLASS NOTATIONS

NR483 E DT R07

EDITION DECEMBER 2025

BUREAU VERITAS

BUREAU VERITAS MARINE & OFFSHORE
RULES FOR CLASSIFICATION

NR483 E DT R07 DECEMBER 2025

Unless otherwise specified, these rules apply to ships which are contracted for consctruction on or after 1 December 2025. The Society may refer to the contents hereof before 1 December 2025, as and when deemed necessary or appropriate.

The PDF electronic version of this document available on the Bureau Veritas Marine & Offshore website **https://marine-offshore.bureauveritas.com/** is the official version and shall prevail if there are any inconsistencies between the PDF version and any other available version.

These rules are provided within the scope of the Bureau Veritas Marine & Offshore General Conditions, enclosed at the end of Part A of NR467, Rules for the Classification of Steel Ships. The latest version of these General Conditions is available on the Bureau Veritas Marine & Offshore website.

BUREAU VERITAS MARINE & OFFSHORE

Tour Alto
4 place des Saisons
92400 Courbevoie - France
+33 (0)1 55 24 70 00

marine-offshore.bureauveritas.com/rules-guidelines

Rules for Classification
NR483

RULES FOR THE CLASSIFICATION OF THE NAVAL SHIPS

Part E
Additional Class Notations

December 2025

Table of Content

Chapter 1 Military Environment

Table of Content

Table of Content

Chapter 6 Comfort on Board (COMF)

Chapter 7 Environmental Protection (CLEANSHIP)

Table of Content

Chapter 9 Manoeuvrability, Stability and Sea-Keeping

Chapter 10 Safety Equipment and Installations

Chapter 11 Other Notations

Section 1 In-Water Survey Arrangements (INWATERSURVEY)

Section 2 Helicopter Deck (HELICOPTER)

Section 3 Refrigeration Installation (REF-STORE)

Table of Content

Table of Content

Part E
Additional Class Notations

CHAPTER 1
MILITARY ENVIRONMENT

Section 1 ARMOUR

1 General

1.1 Introduction

1.1.1 During their operation, naval ships may be exposed to specific threats induced by weapons shoots. The threats may result from:

- bullets and other high performance projectiles
- splinters from external or internal blasts.

Naval ships are commonly protected from these threats by armour plate, armour compound or other adequate means.

The threats and corresponding levels of protection are defined by the Naval Authority.

1.2 Application

1.2.1 The additional class notation **ARMOUR** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.2.1], to ships fitted with a protection by armour, when the requirements of Articles [2] to [4]of this Section are complied with.

2 Documentation

2.1 Document for information

2.1.1 Confidentiality

The documentation relating to the **ARMOUR** notation is treated as confidential, in accordance with the Society General Conditions (item 11), and any additional confidentiality level defined by Naval Authority, if any.

2.1.2 Armouring table

The following documentation is to be consolidated in an “armouring table” to be submitted to the Society for information:

- list of protected areas / compartments / structural modules. The concerned protected areas should be clearly described, in longitudinal - transverse - vertical location and in extend
- nature of armour components, for each protected area in the above list. In particular, the following information should be documented:
  - armour mechanical properties
  - thickness of different barriers or protective plates
  - armour configuration in simple / double plates, gaps, etc.

The armour components should be duly identified by a reference such as to allow management of information without ambiguity (see Article [3]).

- for each armour component of the above list:
  - description of the connection arrangement and the connection means to the ship structure (welding, bounding, bolting, etc)
  - load-carrying capability for normal loads exerted during navigation or operation in peace-time
  - possible welding restriction on the armour plate after installation on board, if any.

The above armouring table submitted to the Society should evidence formal acceptance by the Naval Authority.

3 Armour requirements

3.1 Strength

3.1.1 Special attention should be given to the connection of the armour components listed in the armouring table with the surrounding ship structural elements.

In particular, the following should be checked:

- the ship structure should be adequately reinforced to support the weight of the armour components
- the details of ship structure reinforcements should be shown on structure drawings submitted to the Society
- the external or internal loads during navigation or operation in peace-time should not be transferred to the armour component, if it is specified as non load-carrying in the armouring table.

3.2 Stability

3.2.1 The stability documentation submitted for the ship should adequately take into account the relevant datas of the amour components (weight, location on board, etc.).

3.3 Fire safety

3.3.1 Armour including combustible materials will be considered on a case by case basis.

4 Surveys

4.1 Construction Surveys

4.1.1 Welding

In case the armour component is welded to the ship structure, the relevant Welding Procedure Specification should be subject to Classification acceptance.

4.1.2 Compliance with armouring table

The presence on board of various armour components is checked during Surveyor's inspection, on basis of the armouring table specified in [2.1.2].

4.1.3 Installation on board

The fitting on board is checked based on the documents mentioned in [3.1].

Section 2 SHOCK

1 General

1.1 Assignment of the additional notation SHOCK

1.1.1 Condition for assignment

The additional class notation **SHOCK** is assigned to a ship which complies with the requirements of both the notations **SHOCK STRENGTH** and **SHOCK EQUIPMENT** described in [1.2] and [1.3] respectively. In this case, the notation **SHOCK** replaces the notations **SHOCK STRENGTH** and **SHOCK EQUIPMENT**.

1.2 Assignment of the additional notation SHOCK STRENGTH

1.2.1 Scope

The additional class notation **SHOCK STRENGTH** is assigned to a ship in order to certify that measures are taken to increase her survivability following threat damage to the structures from an assigned underwater non-contact explosion. This notation considers loads coming from underwater non-contact explosions of either submarine mines or torpedoes.

1.2.2 Condition for the assignment

The assignment of the notation **SHOCK STRENGTH** implies that a detailed structural analysis or a test have been carried out, for compliance with Articles [2], [3] and [4] taking also into account the dynamic vertical bending and vibrations that can be induced by the assigned underwater non-contact explosion. Details of the calculations and testing methods and the structural performance achieved, based on the specified loads, will not be published and will be only disclosed to the Naval Authority.

1.2.3 Documentation to be submitted

The following confidential input data are to be submitted for information:

- the loading scenarios, as defined in [2.2]
- the description of the calculation procedures
- the assumptions made
- the details of the software used and its validation as appropriate
- the summary of the results obtained.

1.2.4 Assignment of the notation

If requested by the Naval Authority or by the Shipyard, the **SHOCK STRENGTH** notation is assigned by the Society if the acceptance criteria specified in this Section are fulfilled.

1.3 Assignment of the additional notation SHOCK EQUIPMENT

1.3.1 Scope

Pieces of equipment which are required to resist, to a certain extent, the shock loads due to an underwater explosion near the ship are to comply with the requirements of Articles [5] and [6].

The notation **SHOCK EQUIPMENT** may be assigned to ships where a list of specified pieces of equipment have been satisfactorily shock tested and subsequently fulfil the shock resilience criteria specified by the Naval Authority for the applicable design shock level.

1.3.2 Conditions for assignment

The assignment of the notation **SHOCK EQUIPMENT** is contingent upon the application of the following steps:

a) the critical pieces of equipment are specified by the Naval Authority

b) miscellaneous shock levels are defined by the Naval Authority

c) miscellaneous performance criteria are defined by the Naval Authority

d) each piece of equipment is associated to one or several shock levels and performance criteria

e) shock testing for the given shock level is performed for each equipment

f) performance criteria for equipment after shock testing is evaluated.

1.3.3 Documents to be submitted

For each piece of equipment required to be assessed under shock conditions, the following documents are to be submitted for review:

a) equipment general arrangement drawing, showing actual possible orientation on board

b) detailed supporting arrangement, including mountings specifications and arrangement

c) design shock level applicable.

2 Principles of the additional notation SHOCK STRENGTH

2.1 Underwater explosions

2.1.1 Non contact underwater explosions

A non contact underwater explosion is an explosion caused by the detonation of either a submarine mine or a torpedo warhead occurring at a distance such that the effects of the gas bubble impinging directly on the ship structures are negligible.

2.1.2 Bubble evolution and loading mechanisms

The evolution of the bubble and the corresponding field pressure, without any obstacle, is schematically shown in Fig 1. This implies two types of loading mechanisms:

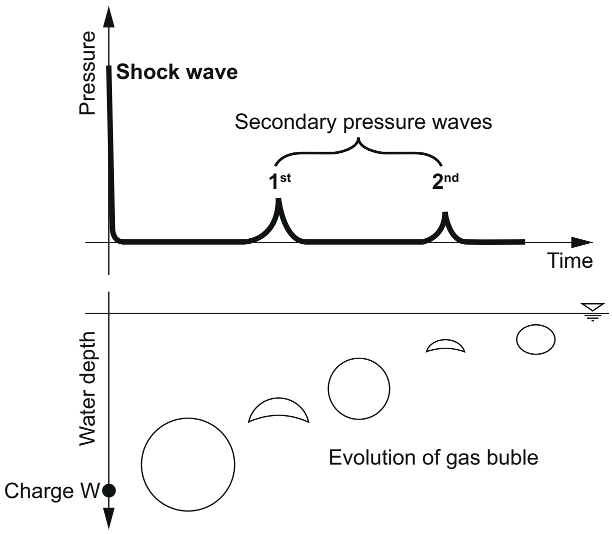
- shock wave
- bubble pulsations.

Two types of loadings have fundamentally different physics and do not have the same consequences on the ship structure. The duration of the shock wave is extremely small (few milliseconds) and it affects the local hull structure as described in Article [3], while the duration of the pressure pulses are much longer and can induce the global hull girder vibrations (whipping) as described in Article [4].

2.1.3 Whipping

Whipping is defined as the transient beam-like, low frequency response of a ship caused by external transient loading.

Figure 1 : Evolution in time of the pressure field and the gas bubble migration process



2.2 Loading scenarios

2.2.1 Description of loading scenarios

A loading scenario is defined by a charge and its location with respect to the ship:

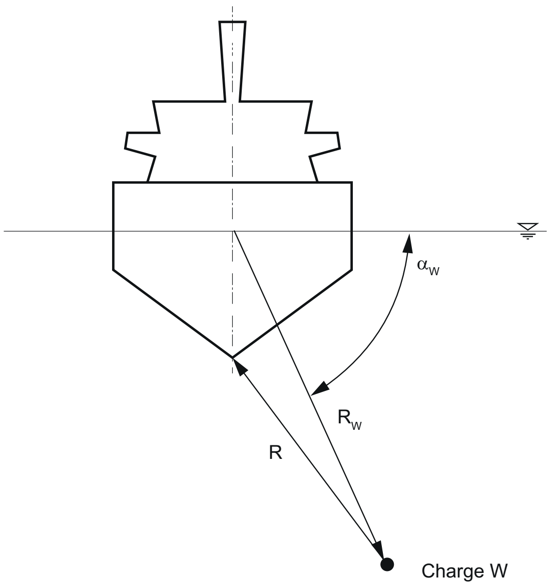
W : Charge mass of TNT equivalent, in kg

Rw : Distance, in m, between the center of the explosion and the point, in the plane of the explosion perpendicular to the longitudinal axis of the ship, defined as the intersection between the waterline and the longitudinal plane of symmetry of the ship

αw : Relative angle of the charge location with respect to the free surface, as shown in Fig 2.

X_W : Longitudinal position of the center of the explosion with respect to the midship section.

Figure 2 : Definition of the charge position



2.2.2 Specification of loading scenarios

The loading scenarios to be used should be specified by the Naval Authority.

2.2.3 Shock factor

A quantity used to characterize the severity of the shock wave is called shock factor and is defined by the following expression:

$$SF = \frac{\sqrt{W}}{R}$$

where:

R : Standoff distance i.e. the distance from the charge to the closest hull point, in m, as shown in Fig 2.

This quantity is often used to specify the loading scenarios. It should however be complemented by the value of the mass W and the depth of the charge (or its relative angle αw).

2.2.4 Remarks

For a given charge W, the worst case for the local structural response to shock wave, is the one corresponding to the smallest distance from the center of explosion to the hull. However for the global whipping response, the worst loading scenario may not be the one with the smallest distance to the hull. Hence, as far as whipping analysis is considered, several distances, higher than the minimum distance specified in the loading scenarios should be considered in the computations.

3 Local structural response to shock wave

3.1 Shock wave modelling

3.1.1 Free field pressure

In the vicinity of the detonation point, the shock wave can be mathematically described as an acoustic pressure field travelling at the speed of sound with the amplitude inversely proportional to the distance and exponentially decaying in time:

$p_0 = p_{max} \exp(-t/\theta)$

p_{max} : Maximum pressure at the distance R from the detonation point, in MPa

$$P_{max} = K_1\left(\frac{W^{1/3}}{R}\right)^{A_1}$$

t : Time, ms

θ : Decay constant depending on the type of charge, in ms

$$\theta = K_2 W^{1/3}\left(\frac{W^{1/2}}{R}\right)^{A_2}$$

The differents constants depend on the type of charge and their values should be agreed with the Society. In the absence of data the values for TNT can be used (see Tab 1).

Another important quantity is the energy per unit area (in MJ/m²), and is given by:

$$E = \frac{\theta P_{max}^2}{2 \cdot \rho \cdot c}$$

where:

ρ : Sea water density to be taken equal to 1025 kg/m^3

c : Speed of sound in sea water to be taken equal to 1500 m/s

This energy per unit area is roughly proportional to the square of the Shock Factor.

Table 1 : Charge dependent constant

K1	A1	K2	A2
52,12	1,18	0,09	–0,185

3.1.2 Loading pressure

The maximum pressure p_{max} can be supposed to occur almost instantly (zero rise time) and the expression (see [3.1.1]) represents the pressure for the field without obstacle. In order to calculate the effective loading pressure p_L to be applied on the hull wetted surface, the diffraction effects are to be taken into account. In the absence of more detailed diffraction analysis, the free field pressure p_0 could be multiplied by 2.

$p_L = 2\ p_0$

3.2 Structural response

3.2.1 General

The structural response to the shock pressure loading defined in [3.1.2], needs to be evaluated by appropriate methods. The type of modelling depends on the complexity of the structural elements.

3.2.2 Plating

In the case of plating a simplified approach may be accepted. This approach might be based on the quasi static assumptions or the simplified dynamic analysis can be employed with the analytical definition of the mode shapes.

3.2.3 Stiffened panels

The structural response of the stiffened panels is to be evaluated using the appropriate nonlinear structural dynamic analysis applying the pressure loading time history defined in [3.1.2]. The strain rate effects should be accounted for in the analysis. Any other alternative numerical method may be accepted on a case-by-case basis.

3.3 Acceptance criteria

3.3.1 Whatever the approach used for the evaluation of the structural response, the calculated strain should not exceed the strain corresponding to the maximum stress in the stress-strain (σ,∈) curve of the corresponding material.

4 Global whipping response

4.1 Evaluation of the dynamic response

4.1.1 General

The mathematical model of the hull girder dynamics should combine the following steps:

- pressure bubble dynamics
- ship hull hydrodynamics
- ship structural dynamics
- coupled hydro-structure dynamics.

4.1.2 Gas bubble dynamics

The gas bubble is pulsating in the surrounding water with the motion tendency to approach the free surface (see Fig 1). As a first approximation the presence of the free surface can be ignored. The practical consequence of this assumption is that the gas bubble keeps the spherical shape during the pulsations, which significantly simplifies the analysis.

The basic assumptions of the mathematical model of the bubble dynamics are:

- the fluid is incompressible and inviscid
- the presence of the ship does not affect the bubble evolution.

Based on the above assumptions, the differential equation for the instantaneous radius of the gas bubble, its first and second time derivatives, can be built and is to be solved in time domain using the recognized numerical techniques. The different parameters of the differential equation should be agreed with the Society. Among the acceptable methods the Double Asymptotic Approximation (DAA) is recommended.

When deemed necessary, the presence of the free surface should be accounted for using the appropriate mathematical model which has to be approved by the Society.

4.1.3 Ship hull hydrodynamics

While vibrating, the hull surface in contact with the water will induce the dynamic pressure which should be taken into account in the global interaction model. The final effect of the induced dynamic pressure can be modelled using the concept of the added mass. The pressure is to be calculated using the recognized 2D/3D potential flow numerical approach. The variation in time of the hydrostatic buoyancy forces should also be taken into account.

4.1.4 Ship structural dynamics

The modal approach is recommended to describe the global structural dynamics and a sufficient number of modes needs to be accounted for, typically more than 20.

4.1.5 Coupled hydro-structure dynamics

The coupled hydro-structure interaction motion equation is to be solved. The gas bubble excitation vector is obtained after projecting the gas bubble pressure [4.1.2] into the hull girder modes and integrating it over the wetted hull surface. The dynamic equation is to be integrated in time and the time history of the vertical bending moment along the ship is to be evaluated. The maximum value of the whipping bending moment at each section is denoted by $M_{Whip}(\chi)$ and this value is to be used to check the acceptance criteria.

4.2 Acceptance criteria

4.2.1 The maximum whipping bending moment $M_{Whip}(\chi)$ is to satisfy the following criteria:

$$M_{Whip}(\chi) \le \frac{M_u(\chi)}{\gamma_R \gamma_M}$$

where:

$M_U(\chi)$: Ultimate bending moment capacity, see Pt B, Ch 6, Sec 3, [2.3.1]

γ_R, γ_M : Partial safety factors, see Pt B, Ch 6, Sec 3, [1.3.1].

4.3 Alternative method

4.3.1 Alternative methods may be used if duly justified and adequately documented to the satisfaction of the Society.

5 Principles of the additional notation SHOCK EQUIPMENT

5.1 Schok levels

5.1.1 Stanag 4549

Stanag 4549 refers to NATO standard Stanag 4549 Edition 1 - Testing of surface ship equipment on shock testing machines. The requirements of this section are in line with the principles identified in this standard, which is considered a recognized standard for shock testing.

5.1.2 Shock response spectra (SRS)

A shock response spectrum is the visualization of the maximum responses of an assembly of massless oscillators (fictitious single degree of freedom systems), having a range of natural frequencies (f), to a given shock motion of the base.

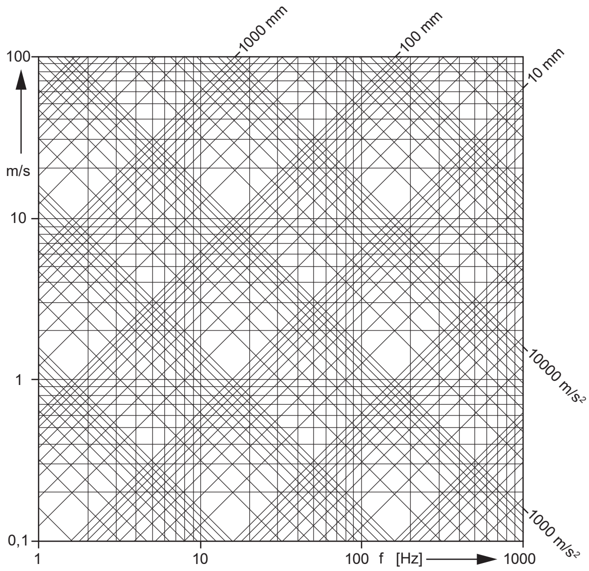
Each shock corresponds to a different time history of acceleration, and reproducing exactly such time series of acceleration is not possible with chock testing machines. This SRS is therefore a way of characterization of a given shock level, which can then be compared to actual shock testing machine motion measurement during the testing phase and ensure that the test is indeed representative of the shock level.

The SRS may be graphically represented on a specific grid shown in Fig 3, and defined as follows:

- Horizontally, the natural frequency is plotted using logarithmic scale.
- Vertically, on a logarithmic scale, there the “pseudo velocity” ω, Z_{max}, where Z_{max} is the absolute value of the maximum relative displacement between the base and the mass of the single degree of freedom system, either occurring during the excitation or thereafter. That is a maximax shock spectrum. The angular natural frequency is:

  $\omega = 2\pi f$
- In the graph, a decade in frequency and a decade in pseudo velocity are to be represented by a same length, preferably 50 mm.
- The graph must show lines rotated 45º anti-clockwise from the horizontal position. These being lines of constant relative displacement Z_{max}.
- The graph must show lines rotated 45° clockwise from the horizontal position. These being lines of constant absolute acceleration, ω2$|Z_{max}|$, of the masses.
- The grid as shown in Fig 3 must have 10 equidistant steps on a linear scale for each decade. This applies to f, $|Z_{max}|$, $\omega|Z_{max}|$ and $\omega^2|Z_{max}|$.

Figure 3 : Typical grid for representation of SRS



5.1.3 Design Shock Level

In order to define the design level of shock motion, a number of standardized shock levels may be defined using 3 parameters SRS parameters, each of these parameters corresponding to a straight line on the grid shown in Fig 3:

- the maximum relative displacement d_0, in meters
- the maximum pseudo velocity v_0, in m/s
- the maximum absolute acceleration a_0, in m/s².

It is generally defined in the frequency range from 4 to 400 Hz:

a) In the lower frequency range between 4 Hz and f_i a constant relative displacement.

b) In an intermediate frequency range between f_i and f_s, a constant pseudo velocity ω, in m/s:

$\omega \; |d_0| = v_0$

Occasionally f_i and f_s may coincide.

c) In the higher frequency range between f_s and 400 Hz, a constant absolute acceleration ω^2, in m/s²:

$\omega^2 \; |d_0| = a_0$

The actual shock levels required for each project are to be specified by the Naval authority and in order to define the Design Shock Level for each equipment, in one the following formats:

- a full SRS directly derived from a design shock level acceleration history
- a standard shock response spectrum NS(d_0, v_0, a_0).

Note 1: f_i and f_s depend on the values for d_0, in m; v_0 in m/s and a_0 in m/s²:

$f_i = v/2\pi d_0$

$f_s = a_0/2\pi \; v_0$

In order that $f_s \geq f_i$, it is a requirement that $v_0 \leq (a_0 d_0)^{0,5}$. The SRS is then entirely defined by these three numerical values.

Note 2: Use of NATO Standardized Shock Levels: NATO Standardized Shock Levels based on such SRS are defined in Stanag 4549, and is identified in with the following term:

NS (relative displacement ; pseudo velocity ; absolute acceleration)

For instance, NS(0,035 ; 3,5 ; 1250) means a NATO standard level of:

- 35 mm relative displacement between 4,0 and 15,9 Hz
- 3,5 m/s pseudo velocity between 15,9 Hz and 56,8 Hz and
- ~125 g absolute acceleration between 56,8 Hz and 400 Hz.

Applications are foreseen within the following ranges:

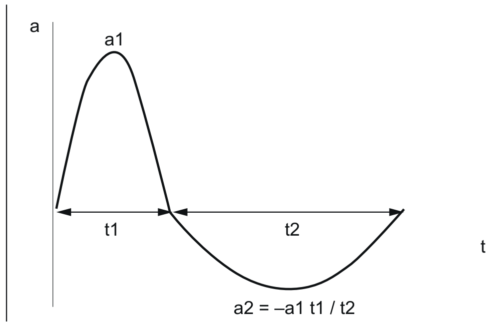
- $0,025 \leq d_0 \leq 0,100$
- $2,5 \leq v_0 \leq 16$
- $250 \leq a_0 \leq 10,000$

5.1.4 Acceleration time history

The shock level can also be specified as an acceleration time history, giving the acceleration (velocity, or displacement) as a function of time. This time history is generally given by the Naval Authority.

In case only a Design Shock Level or a SRS is given, a simple sinusoidal time history, as shown in Fig 4, may be used. The Shock Response Spectrum corresponding to this time history should be computed, and compared to the required Design Shock Level or SRS. The comparison of the spectra is done as specified in [6.1.5]. The various parameters of this simple time history should be tuned until the comparison with the required spectrum is satisfactory.

Figure 4 : Sinusoidal acceleration history



6 Assessment of Equipment

6.1 Assessment by testing

6.1.1 General

Each piece of equipment is to be shock tested in accordance with the requirements of this Section, or following another recognized standard. In particular, these requirements are in line with Stanag 4549.

6.1.2 Arrangement of mountings

The mountings are to be in the same configuration as on board installation during the testing.

When such an arrangement, that is, equipment on mountings, has passed the tests as specified herein, the equipment without mountings or on another type of mountings will not be considered to be in compliance with this Section.

If equipment is on mountings, then other links such as cables and piping may considerably enhance the total stiffness of equipment “suspension”. Depending on the actual situation, these additional connections should also be simulated during testing.

The mounting arrangement plan on board and for testing is to be submitted for review.

6.1.3 Shock direction and attachment to the shock testing machine

Shock in three different shipboard directions are to be simulated by three separate tests:

a) vertically (sense upwards)
b) athwartships (sense not specified)
c) fore and aft direction (sense not specified).

During a test as mentioned under test (b) or test (c) it is allowed to apply at the same time an (unspecified) shock as mentioned under test (a). This is usual practice for some testing machines during so called inclined testing.

Depending on the foreseen orientation of each type of equipment on board, the relevant testing configurations are

required with reference to the equipment local axis (X, Y and Z).

The equipment including its mounting system (if any; see [6.1.2]) is attached through its normal attachment points to the shock testing machine, either directly or by means of fixtures. The attachment and the fixtures are to be such that the measured results are reproducible and that no plastic deformation occur other than in the mountings.

6.1.4 Required test verification

For a given design shock level, the actual shock testing is different according to the testing directions defined in [6.1.3] and applicable depending on the testing cases according to Tab 2.

The tests are to be carried out according to the following requirements:

a) for the test in the upward vertical direction the design shock level as defined in [5.1.3]is to be applied
b) for the test in the athwartships direction a similar spectrum should be used having as a minimum 50% of the d_0, v_0, a_0 values for the vertical test
c) for the test in the fore and aft direction a similar spectrum should be used having as a minimum 25% of the d_0, v_0, a_0 values for the vertical test.

A test for a given equipment comprises at a minimum 3 shocks.

The shock the equipment is subjected is to be measured in accordance with Stanag 4549 or another recognized standard.

Table 2 : Applicable test case depending on equipment orientation on board

	Case 1	Case 2	Case 3
	Only one single possible orientation on board for the equipment **(1)**	Only the vertical axis of the equipment is known, with one single face point upwards **(2)**	The equipment may be mounted in any orientation
Equipment local X axis	test (c) fore and aft direction (sense not specified)	test (b) athwartships (sense not specified)	test (a) vertically (sense upwards)
Equipment local Y axis	test (b) athwartships (sense not specified)	test (b) athwartships (sense not specified)	test (a) vertically (sense upwards)
Equipment local Z axis	test (a) vertically (sense upwards)	test (a) vertically (sense upwards)	test (a) vertically (sense upwards)

(1) In that case, Z is considered as the vertical axis, and X is considered oriented in the longitudinal direction of the ship
(2) In that case, Z is considered as the vertical axis, X and Y axis may be either in the longitudinal or transversal direction of the ship

6.1.5 Comparison of spectra

The acceleration measured during the test is to be converted in a Shock Response Spectrum. The required design shock level is considered to have been met during testing if all measured SRS exceed the required spectra, with the exception of minor excursions.

A measured response spectrum is to exceed the required three-line spectrum, with the exception of frequency ranges where minor excursions occur below the required spectrum.

Further definitions of tolerances, with examples can be found in Appendix 3 to Annex A of Stanag 4549.

6.1.6 Shock testing report

A shock testing report is to be submitted to the Society for review for each equipment, detailing at least the following information:

a) Equipment description:
   1) The name and address of the supplier or manufacturer
   2) References to drawings and full description of equipment as accepted. If modifications during shock testing were introduced and found appropriate during successive testing, such modifications are to be fully documented
   3) The weight and general overall dimensions of the equipment as tested
   4) Description of any mounting system used to support the equipment during the test including the number of mountings fitted, their load range, their location, the type number and the name of the manufacturer of the mountings.

b) Description of actual shock testing:
   1) reference to testing standard
   2) reference to the project applicable design shock level
   3) description of the testing machine
   4) identification of testing authority
   5) detailed installation of the equipment during the test, including mountings
   6) description of each test
   7) description of the instrumentation
   8) for each test, measured velocity signals and maximal shock response spectra.

c) Description of the performance test:
   1) definition of the acceptance criteria for equipment function after shock, according to specified shock resilience criteria
   2) description of any damage
   3) functional performance tests results.

d) General conclusion with acceptable status from the testing authority.

6.2 Assessment by computations

6.2.1 General

As an alternative to the testing, the assessment of large and heavy mechanical components (such as shaft lines, reduction gears, main engines foundations, diesel generators foundations) may be performed based on computations for which the applied methodology is accepted by the Naval Authority.

6.2.2 Type of computations

Dynamic structural analysis should be used based on a structural model of the equipment.

6.2.3 Loading

The structural model is to be loaded by an imposed acceleration time history, as defined in [5.1.4].

6.3 Acceptance Criteria

6.3.1 An equipment is deemed to be qualified for a given design shock level after satisfactory review of an approved test report in accordance with Stanag 4549 and [6.1.6]. For components for which the assessment is based on dynamic structural analysis, the acceptance criteria is to be defined by the Naval Authority.

6.4 Alternative Methods

6.4.1 Any other alternative methods or reference standards that are used to assess the pieces of equipment to be covered by the additional class notation **SHOCK EQUIPMENT** may be considered on a case-by-case basis.

Section 3 Residual Strength

1 General

1.1 Application

1.1.1 This Section applies to ships for which the residual hull girder ultimate strength under damage condition is evaluated according to minimum hull damage scenarios and rule wave hull girder loads defined in Article [2].

Ships complying with the requirements of this Section may be granted with the additional class notation **RS-P**.

2 Design requirements

2.1 Minimum damage scenarios

2.1.1 The two following damage scenarios are to be considered independently between 0,2 L and 0,8 L:

- in-air damages as defined in [2.1.2]
- under-water damages as defined in [2.1.3].

The damage extents defined in [2.1.2] and [2.1.3] are to be measured from the moulded lines of the ship.

Stiffeners are to be considered intact unless the connection of stiffener with attached plate is included in the damage extent.

2.1.2 Transverse extent for in-air damage

The damage extends from the point of intersection of the side shell and the uppermost continuous deck:

- vertically downward for a distance D/4
- transversally inboard for a distance B/2

where B and D are defined in Pt B, Ch 1, Sec 2.

2.1.3 Transverse extent for under-water damage

The damage extends from the point of intersection of the keel line and the side shell:

- vertically upward for a distance D/5
- transversally outboard in one direction for a distance B/3.

where B and D are defined in Pt B, Ch 1, Sec 2.

2.2 Hull girder residual strength check

2.2.1 Hull girder loads

The vertical bending moment M_D, in kN.m, to be considered for the check of ultimate hull girder strength in damaged condition, is to be obtained from the following formula:

- in hogging condition:

  $M_{D,H} = M_{SW,H} + 0,825\ M_{WV,H}$
- in sagging condition:

  $M_{D,S} = M_{SW,S} + 0,825\ M_{WV,S}$

where:

$M_{SW,H}$: Maximum still water bending moments calculated in hogging condition, as defined, in Pt B, Ch 5, Sec 2, [2.2]

$M_{SW,S}$: Maximum still water bending moments calculated, in sagging condition, as defined, in Pt B, Ch 5, Sec 2, [2.2]

$M_{WV,H}$: Vertical wave bending moments calculated in hogging condition, as defined, in Pt B, Ch 5, Sec 2, [3.1]

$M_{WV,S}$: Vertical wave bending moments calculated in sagging condition, as defined, in Pt B, Ch 5, Sec 2, [3.1]

2.2.2 Hull girder ultimate bending capacity in the damaged condition

The hull girder ultimate bending capacity in damaged condition M_{UD}, in kN.m, is to be calculated in hogging and sagging conditions according to Pt B, Ch 6, App 1, with the damaged parts assumed not to contribute to the hull girder strength.

When assessing the ultimate bending capacity of the damaged hull transverse sections:

- damaged area as defined in [2.1] is to be removed from the capacity model
- the hull girder longitudinal members are to be considered with their net scantlings according to Pt B, Ch 6, Sec 1, [2].

2.2.3 Checking criteria

The vertical hull girder ultimate bending capacity in the damaged condition at any hull transverse section located between 0,2 L and 0,8 L is to satisfy the following criteria:

$$\frac{M_{UD}}{\gamma_R \gamma_m} \geq M_D$$

where:

M_{UD} : Ultimate bending moment capacity of the hull transverse section considered, in kN.m:

- In hogging condition:
  $M_{UD} = M_{UD,\,H}$
- In sagging condition:
  $M_{UD} = M_{UD,\,S}$

M_D : Vertical bending moment, in kN.m, defined in [2.2.1]

γ_m : Partial safety factor for material defined in Pt B, Ch 6, Sec 3

γ_R : Partial safety factor for resistance defined in Pt B, Ch 6, Sec 3.

Section 4 FFS

1 General

1.1 Scope

1.1.1 The additional class notation **FFS** is assigned in accordance wit Pt A, Ch 1, Sec 2, [6.2.4] to ships provided with flooding fighting systems allowing to cope with the ingress of great amount of water resulting from a hull damage, or a sea water pipe breaking, by maintaining ship functions totally or partially as considered by the Naval Authority and by maintaining at a limited level the flooding of the compartment suffering a water ingress

1.2 Application

1.2.1 Compartments to be covered

Flooding fighting systems are to be provided, covering, as a minimum, the largest machinery compartment and the compartments containing the main propulsion prime movers and associated main energy sources.

1.3 Definitions

1.3.1 Clean bilge system

Clean bilge system, also called bilge system in this section, means the bilge system required by Pt C, Ch 1, Sec 10, [6] in any watertight compartment other than spaces permanently dedicated to the carriage of fresh water, ballast water, fuel oil or JP5-NATO (F44) and for which other efficient means of pumping are provided, under all practical conditions.

1.3.2 Flooding fighting system

A Flooding Fighting System (FFS) includes suction and overboard discharge piping, pumps, ejectors, and associated instrumentation and control system.

1.4 Documents to be submitted

1.4.1 The documents listed in Tab 1 are to be submitted.

Table 1 : Documentation to be submitted

No.	I/A(**1**)	Documents
1	A	Diagram of the flooding fighting piping systems
2	A	Capacity, prime mover and location of the pumps and ejectors
3	I	Overboard discharges of FFS piping systems showing positions related to the deepest subdivision waterline
4	I	Pressure loss calculations in case of a FFS serving several compartments
5	A	Material, external diameter and wall thickness of the pipes
6	A	Material, type and size of the accessories
7	I	Nature, service temperature and pressure of the fluids used for the operation of the FFS
8	A	Type of connections between pipe lengths, including details of weldings, where provided
9	A	Location of the controls of the flooding fighting systems
10	I	Pump approval certificates
11	I	Drawings showing the design of the on-board testing devices if any
12	I	List of compartments protected by a FFS approved by the Naval Authority
13	A	Construction drawing of the pumps and ejectors
14	I	Characteristics of the means of pumping, flow versus ΔP
15	I	Drawings of the priming devices and related operation instructions
16	I	Material characteristics of pumps and ejectors
17	I	Workshop test results for the means of pumping
(1) A: To be submitted for approval; I: To be submitted for information		

2 Design of flooding fighting systems

2.1 General

2.1.1 Segregation by compartment

An FFS is normally to serve a single watertight compartment.

Several compartments may however be served by the same FFS provided:

a) they are located in the same safety zone.

b) the FFS can manage one single damage for the most demanding compartment. When required by the Naval Authority, the FFS may be required to cope with damages on several compartments. Calculations showing possibility of operating such common piping systems and pumps taking into account the pressure losses are to be provided.

c) the branch of the flooding fighting system serving one compartment can be isolated from the rest of the system by a valve able to be maneuvered locally and remotely from a position located on or above the damage control deck.

d) the risk of progressive flooding and the risk of flooding a healthy compartment when pumping water from a damaged compartment are avoided.

2.1.2 Location

a) Location of pipes and pumps with respect to the ship side: flooding fighting means of pumping and piping system are not to be situated at a distance less than B/5 from the ship side, where B is the ship's width. This does not apply to the portion of piping leading the water to the overboard discharge at the ship side.

b) Compartment completely located inside the B/5 area: in case this kind of design has been chosen:

   1) means of pumping are to be installed outside the compartment

   2) the associated piping system inside the compartment is to be installed as far away as possible from the side of the ship

   3) a valve able to isolate the portion of the piping system located inside the flooded compartment from the rest of the flooding fighting system is to be installed. This valve is to be able to be manoeuvred locally and remotely from a position located on or above the damage control deck and an indication is to be provided at the damage control station showing the actual position of the valve or whether the valve is fully closed or fully open.

c) location of the flooding fighting system controls : the controls of each FFS are to be grouped at one location per system on or above the damage control deck. An instruction notice is to be displayed close to the controls.

d) the overboard discharges of the flooding piping systems are to be located above the deepest subdivision waterline unless a calculation is provided assessing the ability of the system to operate with overboard discharges below the deepest subdivision waterline. In any case, the overboard discharge is to be fitted with a valve operable from a position on or above the damage control deck and an indication is to be provided at the damage control station showing the actual position of the valve or whether the valve is fully closed or fully open.

2.1.3 Pooling clean bilge system

Pooling the clean bilge system and flooding fighting system together may be considered by the Society if agreed by the Naval Authority and provided:

a) the clean bilge system is serving only the compartments considered for the flooding fighting system

b) requirements for both the clean bilge system and the flooding fighting system are applied.

When the compartment or group of compartments is also served by a bilge system and by an emergency bilge system, as required by NR467 Pt C, Ch 1, Sec 10, [6], pooling the emergency bilge system and flooding fighting system together may be considered by the Society if agreed by the Naval Authority and provided:

a) the emergency bilge system is serving only the compartments considered for the flooding fighting system

b) requirements for both the emergency bilge system and the flooding fighting system are applied.

2.2 Design requirements

2.2.1 Unless otherwise mentioned in this section, rules for piping systems mentioned in Pt C, Ch 1, Sec 10, [1] to Pt C, Ch 1, Sec 10, [5] and Pt C, Ch 1, Sec 10, [19] are to be complied with. The FFS is to be considered as a bilge system for the purpose of applying material-related requirements.

2.3 Means of pumping

2.3.1 Arrangement of the means of pumping

For each flooding fighting system, at least two fixed means of pumping are to be provided including at least one power pump.

2.3.2 Capacity of the means of pumping

The pumping capacity for the flooding fighting system in each compartment referred to in [1.2] is to be not less than the capacity determined by the following formula:

$$Q = 0,36W^{2/3}\sqrt{2gh}$$

where:

- Q : Total capacity of pumps serving the compartment(s), in m^3/h
- W : Volume of the compartment(s), in m^3. In case the compartment(s) extends above the margin line, W is to be taken as the volume of the compartment(s) located below the margin line.
- g : Gravity constant (9,81 m/s^2)
- h : Vertical distance between the waterline at full displacement of the ship and the maximum level L which may be reached in the compartment, in m, see Fig 1.

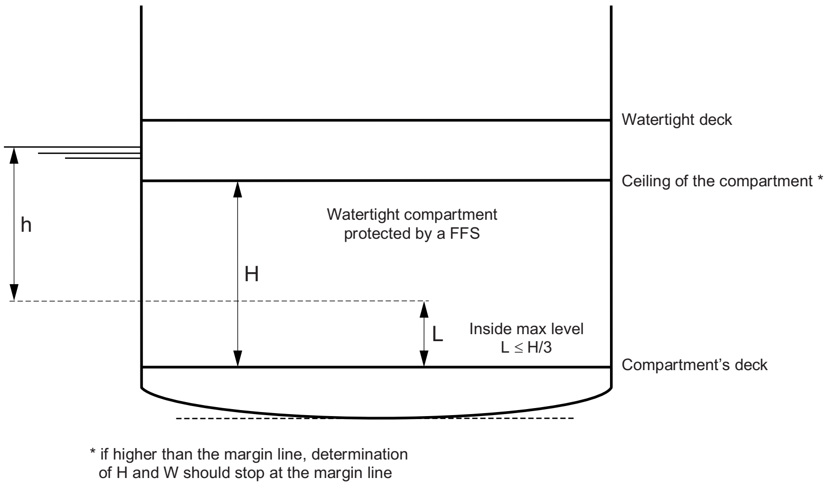
The maximum level L is to be taken as:

- the lowest location of sensitive equipment of which failure means partial unavailability of a primary essential service (see Pt C, Ch 2, Sec 1, [3.11]), electric switchboard, cabinet or junction box
- H/3, where H is the height of the compartment(s). If the compartment(s) extends above the margin line, determination of H should stop at the margin line

whichever is the smaller.

In case the FFS is serving several compartments, the requirements of [2.1.1], item b) are to be complied with.

Figure 1 :



2.3.3 Type of pumps

a) Flooding fighting pumps are to be of the self-priming type. Centrifugal pumps are to be fitted with efficient priming means, unless an approved priming system is provided to ensure the priming of pumps under normal operating conditions.

b) Flooding fighting power pumps are to be suitable to operate when submersed in seawater.

c) Arrangements are to be provided to start the motor of dedicated flooding power pumps from the damage control station and locally.

2.3.4 Power supply for the power pumps

The means of pumping powered by electricity are to be able to be fed by two different parts of the main switchboard supplied by different generating sets.

2.4 Piping

2.4.1 Size of flooding fighting pipes

The actual internal diameter of flooding fighting system pipes is to be calculated assuming a water velocity less than 5 m/s. It is in any case not to be less than 125 mm.

2.4.2 Distribution of suctions

One direct suction per compartment covered is to be fitted for each pump or ejector, located at a low point well below maximum level L commensurate with a reasonably short length of suction pipe.

2.4.3 Discharge of the means of pumping

In case the discharge of several means of pumping inside a single compartment is common, the design of the piping system is to allow to pump the water out of the compartment when only one means of pumping is used.

If located inside the compartment protected by the FFS, the isolating valves provided for this purpose are to be operable from a position on or above the damage control deck and an indication is to be provided at the damage control station, showing the actual position of the valve or whether the valve is fully closed or fully open.

3 Certification and testing

3.1 Certification of pumps

3.1.1 General

The means of pumping are to:

- have their design approved according to [3.1.2]
- be able to work in immersed conditions
- have the materials and casing tested according to Pt C, Ch 1, Sec 10, [19] as bilge pumps
- be able to run on a limited time without pumping water, to be demonstrated by testing

Individual certifications or type approval schemes might be used.

3.1.2 Design approval

Documentation as included in Tab 1 is to be submitted to the Society in order to check compliance with the design requirements given in [2.3.3].

3.1.3 Test at the workshop

Immersed conditions test is to be undertaken in the presence of a Surveyor according to a standard approved by the Society.

Additional tests as mentioned in Pt C, Ch 1, Sec 10, [19] for bilge pumps are to be undertaken in the presence of a surveyor for the pressure test for the casing and the performance test. The performance test is to reflect at minima the conditions encountered onboard, especially those related to counterpressure. Results of the other mentioned tests are to be provided to the Surveyor.

3.1.4 Certificates

Class certificate is to be issued after the completion of tests mentioned in [3.1.3] and approval of drawings.

Work certificates are to be provided to the Society related to materials, balancing and vibration tests.

In case of a type approval, scheme I or II is to be applied according to NR320.

3.2 Tests on board

3.2.1 Proper operation of each FFS is to be tested after the installation onboard by starting the pumps during a limited time.

CHAPTER 2
SYSTEM OF TRACE AND ANALYSIS OF RECORDS (STAR)

Section 1 Star-Hull

1 General

1.1 Principles

1.1.1 Application

The additional class notation **STAR-HULL** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.3.2], to ships complying with the requirements of this Section.

1.1.2 Scope

The additional class notation **STAR-HULL** is assigned to a ship in order to reflect the fact that a procedure including periodical and corrective maintenance, as well as periodical and occasional inspections of hull structures and equipment, (hereafter referred to as the Inspection and Maintenance Plan) are dealt with on board by the crew and at the Naval Authority's offices according to approved procedures.

The assignment of the notation implies that a structural tridimensional analysis has been performed for the hull structures, as defined in Pt B, Ch 7, App 1 or Pt B, Ch 7, App 2 or Pt B, Ch 7, App 3, as applicable.

The implementation of the Inspection and Maintenance Plan is surveyed by the Society through:

- periodical audits carried out at the Naval Authority's offices and on board
- examination of the data recorded by the Naval Authority and made available to the Society through an electronic ship database suitable for consultation and analysis
- periodical check of the hull structure, normally at the class renewal survey, against defined acceptance criteria and based on:
  - the collected data from actual implementation of the Inspection and Maintenance Plan
  - the results of the inspections and other checks carried out during the class renewal survey (see [5]).

1.2 Conditions for the assignment and maintenance of the notation

1.2.1 Assignment of the notation

The procedure for the assignment of the **STAR-HULL** notation is the following:

- a request for the notation is to be sent to the Society:
  - signed by the Interested Party applying for the classification, in the case of new ships
  - signed by the Naval Authority, in the case of existing ships
- the following documents are to be submitted to the Society by the Interested Party:
  - plans and documents necessary to carry out the structural analysis, and information on coatings and on cathodic protection (see [2.1])
  - the hot spot map of the structure identified by the FEM analysis (see [2.2])
  - the Inspection and Maintenance Plan to be implemented by the Naval Authority (see [2.3])
  - information concerning the ship database and relevant electronic support to be implemented by the Naval Authority (see [1.3.1])
- the Society reviews and approves the initial Inspection and Maintenance Plan, taking into account the results of the structural analysis, as well as the information concerning the ship database
- the Society carries out an initial shipboard audit to verify the compliance of the procedures on board with respect to the submitted documentation.

1.2.2 Maintenance of the notation

The maintenance of the **STAR-HULL** notation is based on the following surveys and checks, whose scope and periodicity are specified in [5], to be carried out by the Society:

- annual audits at the Naval Authority's offices (see [5.1])
- annual shipboard audits (see [5.2])
- class renewal surveys (see [5.3]).

1.3 Ship database

1.3.1 The ship database, to be available on board and at the Naval Authority's offices, using an electronic support suitable for consultation and analysis, is to provide at least the following information:

- the hot spot map, as indicated in [2.2]
- the documents required for the Inspection and Maintenance Plan, as indicated in [2.3], and the corresponding reports during the ship operation, as indicated in [3.5].

The ship database is to include a backup system in order for the data to be readily restored, if needed.

1.3.2 The ship database is to be:

- updated by the Naval Authority each time new inspection and maintenance data from the ship are available
- kept by the Naval Authority.

Access to the databases is to be logged, controlled and secured.

1.3.3 The ship database is to be made available to the Society. This ship database is to be transmitted to the Society at least every six months. It may be agreed between the Naval Authority and the Society that the required data are automatically downloaded into the Society's ship database after they are collected.

2 Documentation to be submitted

2.1 Plans and documents to be submitted

2.1.1 Structural analysis

The plans and documents necessary to support and/or perform the structural analysis covering hull structures are:

- those submitted for class as listed in Pt B, Ch 1, Sec 3, for new ships
- those listed in Tab 1, for existing ships or after major repair or renewal for these ships. However, depending on the service and specific features of the ship, the Society reserves the right to request to the Naval Authority additional or different plans and documents from those in Tab 1.

Table 1 : Existing ships - Plans and documents to be submitted to perform the structural analysis

Plans and documents
Midship section
Transverse sections
Shell expansion
Longitudinal sections and decks
Double bottom
Pillar arrangements
Framing plan
Deep tank and ballast tank bulkheads
Watertight subdivision decks and bulkheads
Watertight tunnels
Fore part structure
Aft part structure
Last thickness measurement report

2.1.2 Coatings

The following information on coatings is to be submitted:

- list of all structural items which are effectively coated
- characteristics of the coating system.

2.1.3 Cathodic protection

The following information on sacrificial anodes is to be submitted:

- localisation of anodes in spaces, on bottom plating and sea chests
- dimensions and weight of anodes in new condition.

When the protection against corrosion is achieved by means of impressed currents, the description of the system and the operating manual are to be provided to the Society.

2.2 Hot spot map

2.2.1 The items to be included in the hot spot map are, in general, the following:

- items (such as a plating panels, ordinary stiffeners or primary supporting members) for which the structural analysis carried out at the classification phase for new ships showed that the ratio between the applied loads and the allowable limits exceeded 0,975
- items identified as “hot spot item” during the structural reassessment according to Ch 2, App 2, or after repair or renewal for these ships under the Naval Authority responsibility
- structural details subjected to fatigue, based on the list defined in Pt B, Ch 11, App 1
- other items depending on the results of structural FEM analyses and/or on experience.

2.2.2 The updated hot spot map may indicate which items are to be inspected periodically under the Naval Authority’s responsibility.

2.3 Inspection and Maintenance Plan (IMP)

2.3.1 The Inspection and Maintenance Plan is to be based on the Naval Authority’s experience and on the results of the structural analyses including the hot spot map.

The Inspection and Maintenance Plan is to include:

- the list of areas, spaces and hull equipment to be subjected to inspection
- the periodicity of inspections
- the elements to be assessed during the visual examination for each area or space, as applicable:
  - coating
  - anodes (if any)
  - pitting
  - fractures
  - deformations
- the elements to be assessed during the inspection of hull equipment.

2.3.2 As regards the maintenance plan, the following information is to be given by the Naval Authority:

- maintenance scope
- maintenance type (inspection, reconditioning)
- maintenance frequency (periodicity value unit is to be clearly specified, i.e. hours, week, month, year)
- place of maintenance (port, sea, etc.)
- manufacturer’s maintenance and repair specifications, as applicable
- procedures contemplated for repairs or renewal of structure or equipment.

3 Inspection and Maintenance Plan (IMP)

3.1 Minimum requirements

3.1.1 The minimum requirements on the scope of the Inspection and Maintenance Plan (IMP), the periodicity of inspections, the extent of inspection and maintenance to be scheduled for each area, space or equipment concerned, and the minimum content of the report to be submitted to the Society after the inspection are given hereafter.

3.1.2 At the Naval Authority’s request, the scope and periodicity may be other than those specified below, provided that this is agreed with the Society.

3.1.3 The IMP performed at periodical intervals does not prevent the Naval Authority from carrying out occasional inspections and maintenance as a result of an unexpected failure or event which may affect the hull or hull equipment condition.

Interested parties are also reminded that any damage to the ship which may affect the class is to be reported to the Society.

3.2 General scope of IMP

3.2.1 The IMP is to cover at least the following areas/items:

- deck area structure
- access hatches
- deck fittings
- steering gear
- superstructures
- shell plating
- tanks, including peaks,
- rudders
- sea connections and overboard discharges
- sea chests
- propellers.

3.3 Periodicity of inspections

3.3.1 Inspections are to be carried out at least with the following periodicity:

- Type 1: two inspections every year, with the following principles:
  - one inspection is to be carried out outside the window provided for the execution of the annual class survey, in the vicinity of the halfway date of the anniversary date interval
  - the other inspection is to be carried out preferably not more than two months before the annual class survey is conducted
  - the minimum interval between any two consecutive inspections of the same item is to be not less than four months.
- Type 2: inspection at annual intervals, preferably not more than four months before the annual class survey is carried out.
- Type 3: inspection at bottom surveys.

3.3.2 The following areas/items are to be inspected with a periodicity of Type 1:

- deck area structure
- shell plating above waterline
- hatches
- deck equipment
- superstructures
- ballast tanks, including peaks
- dry holds and spaces
- other accessible spaces
- sea connections and overboard discharges.

For ships less than 6 years old, 25% in number of ballast tanks (with a minimum of one) are to be inspected annually, in rotation, so that all ballast tanks are inspected at least once during the 6-year class period.

For ships 6 years old or more, all ballast tanks are to be inspected annually.

3.3.3 The following areas are to be inspected with a periodicity of Type 2:

- bunker and double bottom fuel oil tanks
- fresh water tanks
- cargo tanks, if any.

3.3.4 Whenever the outside of the ship’s bottom is examined in drydock or on a slipway, inspections are to be carried out on the following items:

- rudders
- propellers
- bottom plating
- sea chests and anodes.

In addition, the requirement under Pt A, Ch 2, Sec 2, [5.4.2] is to be complied with.

3.4 Extent of inspections

3.4.1 Deck area structure

The deck plating and structures over deck, as applicable, are to be visually examined for assessment of the coating, and detection of fractures, deformations and corrosion.

When structural defects affecting the class (such as fractures or deformations) are found, the Society is to be called by the Naval Authority for occasional survey attendance. If such structural defects are repetitive in similar areas of the deck, a program of additional close-up surveys may be planned at the Society's discretion for the next inspections.

In other cases, such as coating found in poor condition, repairs or renewal are to be dealt with, or a program of maintenance is to be set by the Naval Authority in agreement with the Society, at a suitable time, but at the latest at the next intermediate or class renewal survey, whichever comes first.

3.4.2 Hatches

Hatches are to be visually examined, in particular tightness devices, locking arrangements and coating condition, as well as signs of corrosion.

Any defective tightness device or securing/locking arrangement is to be dealt with. Operating devices of hatch covers are to be maintained according to the manufacturer's requirements and/or when found defective.

For structural defects or coating found in poor condition, refer to [3.4.1].

3.4.3 Deck fittings

The inspection of deck fittings is to cover at least the following items:

- Piping on deck

  A visual examination of piping is to be carried out, with particular attention to coating, external corrosion, tightness of pipes and joints (examination under pressure), valves and piping supports. Operation of valves is to be checked.

  Any defective tightness, supporting device or valve is to be dealt with.
- Vent system

  A visual examination of the vent system is to be carried out. Dismantling is to be carried out as necessary for checking the condition of closure (flaps, balls) and clamping devices and of screens.

  Any defective item is to be dealt with.
- Ladders, guard rails, bulwarks, walkways

  A visual examination is to be carried out with attention to the coating condition (as applicable), corrosion, deformation or missing elements.

  Any defective item is to be dealt with.
- Anchoring and mooring equipment

  A visual examination of the windlass, winches, capstans, anchor and visible part of the anchor chain is to be carried out. A working test is to be effected by lowering a sufficient length of chain on each side and the chain lengths thus ranged out are to be examined (shackles, studs, wastage).

  Any defective item is to be dealt with. For replacement of chains or anchors, the Society is to be requested for attendance.

  The manufacturer's maintenance requirements, if any, are to be complied with.
- Other deck fittings

  Other deck fittings are to be visually examined and dealt with under the same principles as those detailed in the items above according to the type of fitting.

3.4.4 Steering gear

The inspection of the installation is to cover:

- examination of the installation
- test with main and emergency systems
- changeover test of working rams.

3.4.5 Superstructures

The structural part of superstructures is to be visually examined and checked under the same scope as that required for deck structure.

The closing devices (doors, windows, ventilation system, skylights) are to be visually examined with attention to tightness devices and checked for their proper operation.

Any defective item is to be dealt with.

3.4.6 Shell plating

The shell plating, sides and bottom, are to be visually examined for assessment of the coating, and detection of fractures, deformations and corrosion.

When structural defects affecting the class (such as fractures or deformations) are found, the Society is to be called for occasional survey attendance. If such structural defects are repetitive in similar areas of the shell plating, a program of additional close-up surveys may be planned at the Society's discretion for the next inspections.

In other cases, such as coating found in poor condition, repairs or renewal are to be dealt with, or a program of maintenance is to be set by the Naval Authority in agreement with the Society, at a suitable time, but at the latest at the next intermediate or class renewal survey, whichever comes first.

3.4.7 Ballast tanks

Ballast tanks, including peaks, are to be overall surveyed with regards to:

- structural condition (fractures, deformations, corrosion)
- condition of coating and anodes, if any
- fittings such as piping, valves.

A program of close-up survey may also be required, depending on the results of the structural analyses and the hot spot map.

When structural defects affecting the class are found, the Society is to be called for occasional survey attendance. If such structural defects (such as fractures or deformations) are repetitive in similar structures in the same ballast tanks or in other ballast tanks, a program of additional close-up survey may be planned at the Society's discretion for the next inspections.

In other cases, such as coating found in poor condition or anodes depleted, repairs or renewal are to be dealt with, or a program of maintenance is to be set by the Naval Authority in agreement with the Society, at a suitable time, but at the latest at the next intermediate or class renewal survey, whichever comes first.

3.4.8 Dry holds and spaces

Dry holds and other spaces such as vehicle decks are to be subjected to overall examination and dealt with in the case of defects, under the same scope as that required for ballast tanks. Attention is also to be given to other fittings, such as bilge wells (cleanliness and working test) and ladders.

A program of close-up survey may also be required, depending on the results of the structural analyses and the hot spot map.

When structural defects affecting the class are found, the Society is to be called for occasional survey attendance. If such structural defects (such as fractures or deformations) are repetitive in similar structures, a program of additional close-up survey may be planned at the Society's discretion for the next inspections.

3.4.9 Other accessible spaces

Other spaces accessible during normal operation of the ship or port operations, such as cofferdams, void spaces, pipe tunnels and machinery spaces are to be examined and dealt with under the same scope as that required for dry holds and spaces.

Consideration is also to be given to the cleanliness of spaces where machinery and/or other equivalent equipment exist which may give rise to leakage of oil, fuel water or other leakage (such as main and auxiliary machinery spaces and steering gear space).

3.4.10 Rudder(s)

A visual examination of rudder blade(s) is to be carried out to detect fractures, deformations and corrosion. Plugs, if any, have to be removed for verification of tightness of the rudder blade(s). Thickness measurements of plating are to be carried out in case of doubt. Access doors to pintles (if any) have to be removed. Condition of pintle(s) has to be verified. Clearances have to be taken.

Condition of connection with rudder stock is to be verified.

Tightening of both pintles and connecting bolts is to be checked.

3.4.11 Sea connections and overboard discharges

A visual external examination of sea inlets, outlet corresponding valves and piping is to be carried out in order to check tightness. An operation test of the valves and manoeuvring devices is to be performed.

Any defective tightness and/or operability is to be dealt with.

3.4.12 Sea chests

Sea chests have to be examined with regards to:

- structural condition (fractures, deformations, corrosion)
- condition of cleanliness, coating and anodes
- visual examination of accessible part of piping or valve.

3.4.13 Propellers

A visual examination of propeller blades, propeller boss and propeller cap is to be carried out as regards fractures, deformations and corrosion. For variable pitch propellers, absence of leakage at the connection between the blades and the hub is to be also ascertained.

Absence of leakage of the aft tailshaft sealing arrangement is to be ascertained.

3.4.14 Cargo tanks, bunker and double bottom fuel oil tanks, fresh water tanks, as applicable

Bunker and double bottom fuel oil tanks are to be overall surveyed with regards to:

- structural condition (fractures, deformations, corrosion)
- condition of coating and anodes, if any
- fittings such as piping, valves.

Cargo tanks, if any, are to be overall surveyed with regards to:

- structural condition (fractures, deformations, corrosion)
- condition of coating and anodes, if any
- fittings such as piping, valves.

A program of close-up survey may also be required, depending on the results of the structural analyses and the hot spot map.

When structural defects affecting the class are found, the Society is to be called for occasional survey attendance. If such structural defects (such as fractures or deformations) are repetitive in similar structures in the same tank or in other tank, a program of additional close-up survey may be planned at the Society's discretion for the next inspections.

In other cases, such as coating found in poor condition, repairs or renewal are to be dealt with, or a program of maintenance is to be set by the Naval Authority in agreement with the Society, at a suitable time, but at the latest at the next intermediate or class renewal survey, whichever comes first.

3.5 Inspection reports

3.5.1 Inspection reports are to be prepared by the person responsible after each survey. They are to be kept on board and made available to the Surveyor at his request. An electronic form is to be used for this purpose (see [1.3]).

A copy of these reports is to be transmitted to the Naval Authority's offices, for the records and updating of the ship database.

3.5.2 The inspection reports are to include the following.

- General information such as date of inspection/maintenance, identification of the person performing the inspection with his signature, identification of the area/space/equipment inspected.
- For inspection of structural elements (deck area, hatches, superstructures, ballast tanks, dry holds and spaces, other spaces), the report is to indicate:
  - coating condition of the different boundaries and internal structures and, if any, coating repairs
  - structural defects, such as fractures, corrosion (including pitting), deformations, with the identification of their location, recurrent defects
  - condition of fittings related to the space inspected, with description as necessary of checks, working tests, dismantling, overhaul
- For inspection of equipment (deck equipment, sea connections and overboard discharges), the report is to indicate the results of visual examination, working tests, dismantling, repairs, renewal or overhaul performed.

3.5.3 When deemed necessary or appropriate, the report is to be supplemented by documents, sketches or photographs, showing for example:

- location and dimension of fractures, pitting, deformations
- condition of equipment before repairs
- measurements taken if required by the Society.

3.5.4 Models of inspection reports for structural elements and equipment are given in Ch 2, App 5.

These models are to be used as a guide for entering the collected data into the ship database, in an electronic form.

3.6 Changes to Inspection and Maintenance Plan

3.6.1 Changes to ship operation, review of the inspection and maintenance reports, possible subsequent changes to the hot spot map and corrosion rates different than those expected may show that the extent of the maintenance performed needs to be adjusted if any by the Naval Authority to improve its efficiency.

Where more defects are found than would be expected, it may be necessary to increase the extent and/or the frequency of the maintenance program. Alternatively, the extent and/or the frequency of the maintenance may be reduced subject to documented justification.

4 Acceptance criteria

4.1 Coating assessment

4.1.1 Criteria

The acceptance criteria for the coating condition of each coated space is indicated in Tab 2.

Where acceptance criteria are not fulfilled, coating is to be repaired.

4.1.2 Repairs

The procedures for repairs of coatings are to follow the coating manufacturer's specification for repairs, under the Naval Authority's responsibility.

Table 2 : Acceptance criteria for coatings

Condition	Acceptance criteria
Ships less than 12 years old	Coatings in GOOD condition
Ships 12 years old or more	Coatings in GOOD or FAIR condition

Note 1:
GOOD : Only minor spot rusting
FAIR : Local breakdown at edges of stiffeners and weld connections and/or light rusting over 20% or more of areas under consideration, but less than as defined for POOR condition
POOR : General breakdown of coating over 20% or more of areas or hard scale at 10% or more of areas under consideration.

4.2 Sacrificial anode condition (as applicable)

4.2.1 Criteria

The acceptance criteria for sacrificial anodes in each coated space fitted with anodes is indicated in Tab 3 in terms of percentage of losses in weight.

Where acceptance criteria are not fulfilled, sacrificial anodes are to be renewed.

Table 3 : Acceptance criteria for sacrificial anodes

Condition	Percentage of loss in weight
Ships less than 12 years old	less than 25
Ships 12 years old or more	less than 50

4.3 Thickness measurements (applicable only if required by the Society on case by case basis)

4.3.1 General

The acceptance criteria for measured thicknesses are indicated in:

- Ch 2, App 1 for isolated areas of items (for example a localized area of a plate)
- Ch 2, App 2 for items (for example a plating panel or an ordinary stiffener)
- Ch 2, App 3 for zones (for example the bottom zone).

When the acceptance criteria are not fulfilled, actions according to [4.3.2] to [4.3.4] are to be taken.

4.3.2 Isolated area

The thickness diminution of an isolated area of an item is the localized diminution of the thickness of that item such as, for example, the grooving of a plate or a web or a local severe corrosion. It is expressed as a percentage of the relevant as built thickness.

It is not to be confused with pitting (see [4.4]).

If the criteria of acceptable diminution are not fulfilled for an isolated area, then this isolated area is to be repaired or replaced. In any case, the criteria of thickness diminution are to be considered for the corresponding item (see [4.3.3]).

4.3.3 Item

For each item, thicknesses are measured at several points and the average value of these thicknesses is to satisfy the acceptance criteria for the relevant item.

If the criteria of measured thicknesses are not fulfilled for an item, then this item is to be repaired or replaced. Where the criteria are fulfilled but substantial corrosion as defined in Pt A, Ch 2, Sec 2, [3.2.7] is found, the IMP is to be adjusted to increase the frequency and/or extent of the maintenance program. In any case, for the items which contribute to the hull girder longitudinal strength, the criteria in [4.3.4] are to be considered.

4.3.4 Zone

For consideration of the hull girder longitudinal strength, the transverse section of the ship is divided into three zones:

- deck zone
- neutral axis zone
- bottom zone.

The sectional area diminution of a zone, expressed as a percentage of the relevant as built sectional area, is to fulfil the criteria of acceptable diminution for that zone.

If the criteria of acceptable diminution are not fulfilled for a zone, then some items belonging to that zone are to be replaced (in principle, those which are most worn) in order to obtain after their replacement an increased sectional area of the zone fulfilling the relevant criteria.

4.4 Pitting

4.4.1 Pitting intensity

The pitting intensity is defined by the percentage of area affected by pitting.

The diagrams in Ch 2, App 4 are to be used to identify the percentage of area affected by pitting and thus the pitting intensity.

4.4.2 Acceptable wastage

The acceptable wastage for a localised pit (intensity ≤ 3%) is 23% of the average residual thickness.

For areas having a pitting density of 50% or more, the acceptable wastage in pits is 13% of the average residual thickness.

For intermediate values (between localised pit and 50% of affected area), the acceptable wastage in pits is to be obtained by interpolation between 23% and 13% of the average residual thicknesses (see Tab 4).

Table 4 : Pitting intensity and corresponding acceptable wastage in pits

Pitting intensity, in % (see Ch 2, App 4)	Acceptable wastage in pits, in percentage of the average residual thickness
≤ 3	23
5	22
10	21
15	20
20	19
25	18
30	17
40	15
50	13

4.4.3 Repairs

Application of filler material (plastic or epoxy compounds) is recommended as a mean for stopping/reducing the corrosion process but this is not an acceptable repair for pitting exceeding the maximum permissible wastage limits.

Welding repairs may be accepted when performed in accordance with agreed procedures.

4.5 Fractures

4.5.1 General

Fractures are found, in general, at locations where stress concentrations occur.

In particular, fractures occur at the following locations:

- beginning or end of a run of welding
- rounded corners at the end of a stiffener
- traces of lifting fittings used during the construction of the ship
- weld anomalies
- welding at toes of brackets
- welding at cut-outs
- intersections of welds
- intermittent welding at the ends of each length of weld.

The structure under examination is to be cleaned and provided with adequate lighting and means of access to facilitate the detection of fractures.

If the initiation points of the fractures are not apparent, the structure on the other side of the plating is to be examined.

4.5.2 Criteria

Where fractures are detected, the Society's Surveyor is always to be called by the Naval Authority for attendance.

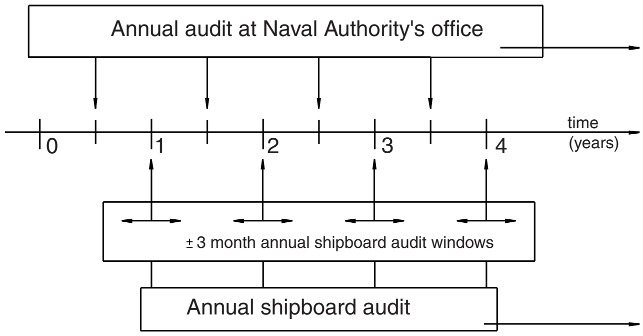
5 Maintenance of the notation

5.1 Annual audit at the Naval Authority's offices

5.1.1 The audit is to be carried out annually preferably within the prescribed six-month window as shown in Fig 1.

If two or more ships belonging to the same Naval Authority are assigned the **STAR-HULL** notation, this annual audit may be performed for all ships at the same time in a suitable period agreed between the Naval Authority and the Society.

Figure 1 : Audit periodicity



5.1.2 The Surveyor checks that the ship database held at the Naval Authority's offices is kept updated, in particular with the inspection and maintenance reports of the IMP.

A preliminary evaluation on how the IMP is applied may be done on the basis of the data and information collected during this audit and the data received from the ship.

Depending on this evaluation, the Society may call for:

- an occasional survey on board the ship by a Surveyor of the Society to be carried out as soon as possible
- corrective actions to be taken by the Naval Authority in applying the IMP.

5.1.3 The annual audit at the Naval Authority's offices performed before the commencement of the class renewal survey is to include the planning required for this survey (see [5.2.2]).

5.2 Annual shipboard audit

5.2.1 The annual shipboard audit is to be carried out concurrently with the annual survey.

5.2.2 During this audit the Surveyor:

- verifies that the ship database is kept updated and transmitted to the Naval Authority's offices
- verifies the consistency and implementation of the IMP
- carries out additional inspections relevant to hull (structure and equipment), if required as a result of the audit at the Naval Authority's offices.

5.3 Class renewal survey

5.3.1 The survey for the renewal of the **STAR-HULL** notation is to be carried out concurrently with the class renewal survey.

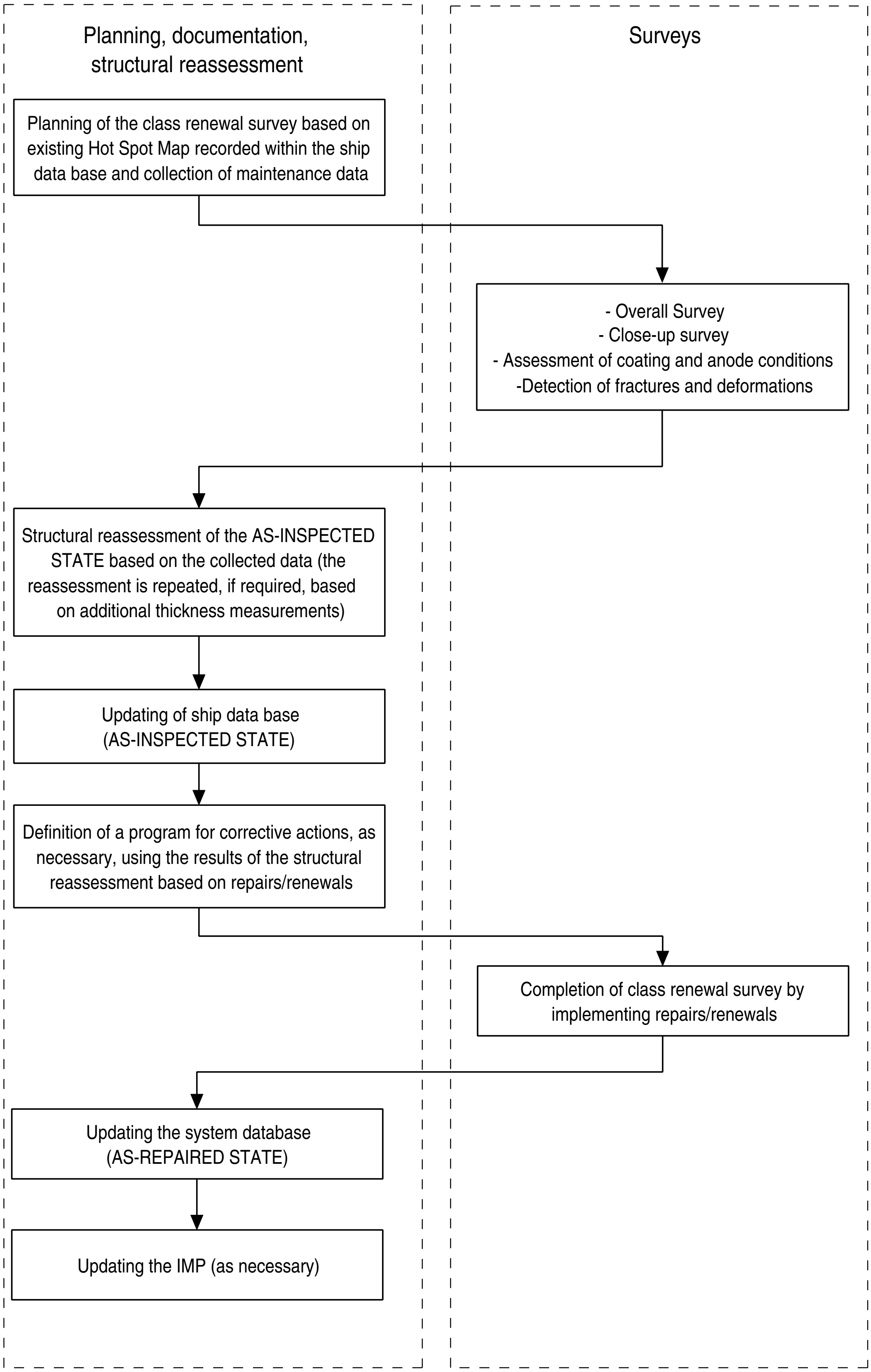
The documentation to be prepared, the surveys to be carried out and the structural reassessment to be done in connection with the class renewal survey are summarised in the flowchart shown in Fig 2.

5.3.2 The planning of the class renewal survey is to be prepared in advance of the survey by the Naval Authority in cooperation with the Society. This planning is preferably to be agreed during the annual audit at the Naval Authority's offices performed approximately eighteen months before the due date of the class renewal survey (see [5.1.3]).

The planning is to include the following information:

- conditions for survey
- provisions and methods for access to structures
- equipment for survey
- indication of spaces and areas for internal examination, overall survey and close-up survey
- indication of tanks to be tested
- indication of areas to be checked for fatigue fracture detection (see [5.3.3]).

Figure 2 : Actions to be taken in connection with the Class Renewal Survey



It is to take account of:

- the results of the IMP held by the Naval Authority during the current class period, as well as the class surveys carried out during the same period
- the scope of the class renewal survey as required in Pt A, Ch 3, Sec 3 and Part A, Chapter 4, as applicable to the ship concerned
- the additional requirements related to the **STAR-HULL** notation as indicated in [5.3.3].

5.3.3 In addition to the scope of the class renewal survey as required for the ship concerned, the following is to be carried out:

- an annual shipboard audit as detailed in [5.2]
- the assessment of the condition of coating and anodes if any
- the close-up survey as required in the survey planning as a result of the previous structural assessment required by the Society on case by case basis
- a specific survey for fatigue fracture detection in accordance with the planning as a result of the previous hot spot map.

5.3.4 On the basis of the results of the surveys, additional visual examination and fatigue fracture detection carried out as indicated in [5.3.3], the “as-inspected state” of the ship is established. A structural reassessment of the “as-inspected state” is performed according to the criteria in Ch 2, App 2. This state may be progressively updated based on the results of additional inspections and/or thickness measurements required on the basis of the first “running” of the analysis.

Once the final “as-inspected state” is established, a program of corrective actions is defined and planned, which may consist of:

- structural renewals
- repairs of structural defects (fractures, deformations, etc.)
- repairs/renewals of coating and/or anodes, if any.

in order to ensure that the ship continues to comply with the acceptance criteria given in Article [4]. In addition, the IMP may be modified if needed.

5.3.5 The corrective actions are to be surveyed by a Surveyor of the Society. Subsequently a new “as-repaired state” of the ship is obtained, including an updated hot spot map.

5.4 Suspension and withdrawal of the notation

5.4.1 The maintenance of the **STAR-HULL** notation is subject to the same principles as those for the maintenance of class: surveys are to be carried out by their limit dates and possible recommendations (related to the notation) are to be dealt with by their limit dates.

The suspension of class automatically causes the suspension of the **STAR-HULL** notation.

5.4.2 Various events may lead either to imposition of a recommendation related to the **STAR-HULL** notation or to suspension of the notation itself. Some cases are given below.

- The condition of the ship is below the minimum level required for class (e.g. scantling of a hull structure below the corrosion margin acceptable for the class around hot spot areas). The action to be taken is either the immediate repair or the imposition of a recommendation for the class (if acceptable) and suspension of the **STAR-HULL** notation. However, in cases where the recommendation is of a minor nature, the notation may not be suspended.
- The Inspection and Maintenance Plan is not complied with (e.g. delays in performing the operations programmed according to the plan or the scope of inspection and/or maintenance not completely fulfilled), and/or the maintenance of the database is not fulfilled.

  The action to be taken is:

  - either the immediate compliance with the requirements or the imposition of a recommendation if the non-conformity is of a minor nature or is an exceptional occurrence
  - or the suspension of the **STAR-HULL** notation if the non-conformity is of a major nature or a recurrence.
- A defect or a deficiency is found in applying the IMP. The actions to be taken are the same as stated both for repair of structure/coating/equipment (first two cases above) and for the application of the IMP (third case above).
- An unexpected defect or deficiency is found or an accident occurs, i.e. not as a result of lack of maintenance or failure in the application of the IMP. The actions to be taken are the same as stated for repair of structure/coating/equipment (first two cases above).

5.4.3 The withdrawal of the **STAR-HULL** notation may be decided in different cases, such as:

- recurrent suspension of the **STAR-HULL** notation
- suspension of the **STAR-HULL** notation for more than a given period (i.e. 3 months)
- expiry or withdrawal of class.

Section 2 Star-Mach

1 General

1.1 Principles

1.1.1 Application

The additional class notations **STAR-MACH** and **STAR-MACH-PMS** are assigned, in accordance with Pt A, Ch 1, Sec 2, [6.3.3] to ships complying with the requirements of this Section.

1.1.2 Inspection and Maintenance Plan

The **STAR-MACH** notation reflects the fact that a procedure including periodic and corrective maintenance, condition-monitoring as well as periodic and occasional inspections of machinery installations and equipment (hereinafter referred to as the Inspection and Maintenance Plan) is operated on board and at the Naval Authority's offices.

The implementation of the Inspection and Maintenance Plan is verified by the Society through:

- a risk analysis, initially performed by the Society in order to identify tentatively critical machinery and equipment items covered in the Inspection and Maintenance Plan, and periodically updated to analyse the performance of these items on the basis of the information stored in the ship database, requiring suitable modifications of the inspection and maintenance intervals, if needed
- periodic examination of the data recorded by the Naval Authority and made available to the Society through an electronic ship database suitable for consultation and analysis; and
- periodic audits carried out by the Society at Naval Authority's offices and on board.

1.1.3 Risk analysis

The purpose of the risk analysis is to assess the inspection and maintenance process taking into account the consequences if a system fails.

The risk analysis is to include at least the machinery and equipment which are identified in [2.1]. The Society, in consultation with the Naval Authority, may extend the scope of the risk analysis to other equipment or systems which are considered critical, depending on the ship's characteristics.

For the purpose of the risk analysis, instruction manuals, spare parts and tools are assumed to be available, when needed.

1.1.4 Class renewal survey

The assignment of the **STAR-MACH** and **STAR-MACH-PMS** notations imply that the class renewal surveys of machinery are carried out by applying the planned maintenance scheme (PMS) described in Pt A, Ch 2, Sec 2. The procedure of recognizing surveys carried out by the Chief Engineer, as indicated in Pt A, Ch 2, Sec 2 when CMS or PMS schemes are adopted, is also applied.

The combination of the Inspection and Maintenance Plan implemented by the Naval Authority and the risk analysis carried out by the Society enables to improve the planned maintenance scheme (PMS), as described in Pt A, Ch 2, Sec 2. For instance, it is possible to allow the inspection of a machinery item based on running hours to be performed at intervals exceeding five years, based on its actual conditions and performances on board.

1.1.5 Manufacturer's recommendations

The **STAR-MACH** notation has by no means to be considered a relapsation or a variation of the type and timing of maintenance recommended by the Manufacturer.

Any possible change or optimization of the original maintenance scheme may be considered only after the expiry of the Manufacturers' warranty period, once that all involved machinery and equipment are set in service and the information relative to the maintenance and performance of various machinery and equipment are collected and elaborated, as necessary, in consultation with the Manufacturer, at Naval Authority's request.

1.2 Conditions for the assignment and maintenance of the notation

1.2.1 Assignment of the notation

The procedure for the assignment of the **STAR-MACH** notation is the following:

- a request for the notation is to be sent to the Society

- the following documentation is to be submitted to the Society by the Interested Party:
  - plans and documents of machinery and equipment (see [2.1])
  - the Inspection and Maintenance Plan to be implemented by the Naval Authority during the ship life (see [2.2]), and
  - information concerning the ship database and relevant electronic support to be implemented by the Naval Authority during the ship life (see [1.3.1])
- the Society performs the risk analysis for the ship and its plants, based on the documentation submitted
- the Society reviews and approves the Inspection and Maintenance Plan, taking into account the results of the above-mentioned risk analysis as well as the information concerning the ship database
- the Society carries out an initial shipboard audit to verify the compliance of the procedures on board with respect to the submitted documentation.

1.2.2 Maintenance of the notation

The maintenance of the **STAR-MACH** notation is based on a risk analysis review (see [3.2]) and the following surveys to be carried out by the Society, according to the scope and periodicity given in [5]:

- annual audit at the Naval Authority's offices (see [5.1])
- annual shipboard audit (see [5.2])
- occasional shipboard audits/surveys (see [5.3]) triggered by:
  - risk analysis results
  - changes to ship operations
  - non-conformities.

1.3 Ship database

1.3.1 The ship database, to be available on board and at the Naval Authority's offices, using an electronic support suitable for consultation and analysis, is to include at least the following information:

- the documents required for the Inspection and Maintenance Plan, as indicated in [2.2], and the corresponding reports during the ship operation, as indicated in [4.2]
- the results of the risk analysis.

1.3.2 The ship database is to be:

- updated by the Naval Authority each time new inspection and maintenance data from the ship are available
- kept by the Naval Authority.

Access to the database is to be logged, controlled and secured.

The ship database is to include a back up system in order that the data can be readily restored, if needed.

1.3.3 The ship database is to be made available to the Society.

The ship database is to be transmitted to the Society at least every six months. When agreed between the Naval Authority and the Society, the required data may be automatically discharged into a Society's database.

1.3.4 The data provided in accordance with [1.3.3] will be used to carry out the risk analysis.

1.3.5 As the risk analysis is subject to be reviewed and updated by the Society during the ship's life, the software used by the Naval Authority is to be compatible with the one used by the Society, in order to make possible the review and updating of the risk analysis results.

2 Documentation to be submitted

2.1 Plans, documents and specifications

2.1.1

a) The plans and documents necessary to assign the **STAR-MACH** notation are to include at least the machinery and equipment listed in Tab 1.

b) For a new ship, the plans and documents listed in Tab 1 do not need to be duplicated with respect to the documents requested for the purpose of classification in Part C.

c) The plans are to be supplemented by Manufacturer's specifications, including the list of relevant equipment and accessories and instructions for their use.

d) The Society may request additional documents or information, when needed.

2.2 Inspection and Maintenance Plan (IMP)

2.2.1 The Inspection and Maintenance Plan is to include at least the following information:

- the list of machinery and equipment covered, including at least the ones listed in Tab 1
- for each item of machinery and equipment:
  - Manufacturer's maintenance instruction book, taking into consideration the scheme recommended by the Manufacturer (see [1.1.5])
  - details relevant to the type of maintenance (e.g. inspection, reconditioning, overhauls, spare parts)
  - maintenance frequency (i.e. running hours, calendar days, weeks, months, years)
  - condition monitoring scheme, where applied
  - place of maintenance execution (e.g. in port, at sea)
  - utilisation rate, running hours and type of service (e.g. heavy, light)
  - procedures foreseen for repairs, overhauling or substitution
- names and qualification of personnel authorized to carry out the duties foreseen by the Inspection and Maintenance Plan (see [4.4])
- procedures for the storage and backup of records and any other relevant information (see [1.3])
- procedure for modification and approval of the plan based on feedback experience and Manufacturer's consultation, as necessary.

Table 1 : List of machinery and equipment for which plans and documents are requested

No.	ITEM
1	General arrangement plan
2	Propulsion plant, including (if applicable): • diesel engines • steam or gas turbines • electric motors for propulsion • gearing • shafting, including bearings and accessories • propellers
3	Steam production and distribution, including (if applicable): • main propulsion boilers and related accessories • main condenser for propulsion boiler • main propulsion steam system including pumps, pipes, valves, filters, etc.
4	Fuel oil heating system, if essential for propulsion, including (if applicable): • steam heaters, including their accessories • thermal oil heaters, including their accessories • electrical plant supplying the electrical heaters
5	Fuel oil system, including: • purifiers • piping system
6	Lubricating oil system, including: • purifiers • coolers (if applicable) • piping system
7	Cooling water system, including: • sea water system • low and high temperature fresh water system • piping system
8	Compressed air system, including compressors and their prime movers and related piping
9	Steering gear, including all equipment and systems necessary for its control
10	Bilge system
11	Ballast system
12	Electricity production and distribution system, including prime movers, generators, cables protections and main switchboard
13	Air ventilation system serving the machinery spaces
14	Fire prevention, detection and fighting system
15	Exhaust gas system
16	Automation and control systems, including information on the possibility for the system to be disconnected in case failure allowing the manual control
17	Any other system or equipment connected in such a way that any single failure of it or part of it might affect the functionality of one of the system, machinery or equipment covered by the risk analysis

3 Risk analysis

3.1 Initial risk analysis

3.1.1 Scope

The scope of the initial risk analysis, to be carried out by the Society in order to assign the **STAR-MACH** notation, is:

- identify critical systems and/or components
- assess the Inspection and Maintenance Plan with regards to currently accepted levels of risk
- recommend measures to improve the type and/or periodicity of inspection and maintenance, when deemed necessary.

3.1.2 Process

The overall process followed by the risk analysis is described in Ch 2, App 6.

3.2 Risk analysis review

3.2.1 Scope

The initial risk analysis carried out in accordance with [3.1] will be kept up-to-date by the Society, on the basis of the information and data gathered from the ship database (see [2.2]), for instance relevant to the actual inspection and maintenance, including failures and repairs, if any.

Where deemed necessary, the updated data will be introduced in the logic probabilistic model for a re-evaluation of the critical systems and components.

When the reviewed risks show a significant deviation from those identified by the initial risk analysis, the Society will recommend modification of the Inspection and Maintenance Plan, for instance in terms of type and periodicity of maintenance (see [2.2]).

3.2.2 Major alterations

In the case of major alterations of the machinery and equipment covered by the **STAR-MACH** notation, the logic probabilistic model defined in accordance with [3.1] will be updated to suit the new arrangements on board.

4 Inspection and Maintenance Plan

4.1 General

4.1.1 The Inspection and Maintenance Plan (e.g. type and frequency of maintenance) is based on the Manufacturer's recommendations, documented experience, condition monitoring and results of the risk analysis (see [3]).

4.2 Inspection and maintenance reports

4.2.1 Inspection and maintenance reports are to be done by the responsible person after each inspection/maintenance operation. They are to be kept on board and made available to the Surveyor on his request. An electronic form is to be used for that purpose (see [1.3]).

A copy of these reports is to be transmitted to the Naval Authority's Office, for their records and updating of the ship data base.

4.2.2 The inspection/maintenance reports are to include:

- running hours and type of service, as applicable (heavy, light)
- frequency of maintenance, timing, time spent for the preventative maintenance
- details relative to the corrective maintenance (overhauls, spare parts, idle time, time between two different stops for maintenance, parts changed and parts reconditioned)
- trend of condition monitoring parameters, where applied
- in case of failure:
  - information on mode and reason of failure
  - time out of service
  - type of repair carried out.

4.3 Changes to the Inspection and Maintenance Plan

4.3.1 Changes to ship operation, condition monitoring, risk analysis review, or any other documented justification may demonstrate that the Inspection and Maintenance Plan needs to be adjusted to improve its efficiency. Where more defects are found than it would be expected, it may be necessary to increase the extent and/or the frequency of the maintenance programme. Alternatively, the extent and/or the frequency of the maintenance may be subject to documented justification and Manufacturer's consultation.

4.4 Responsible persons

4.4.1 The person on board responsible for the collection and process of maintenance data within the scope of the Inspection and Maintenance Plan is to be authorized by the Society in accordance with the procedure established for the recognition of machinery surveys carried out by Chief Engineers (see Part A).

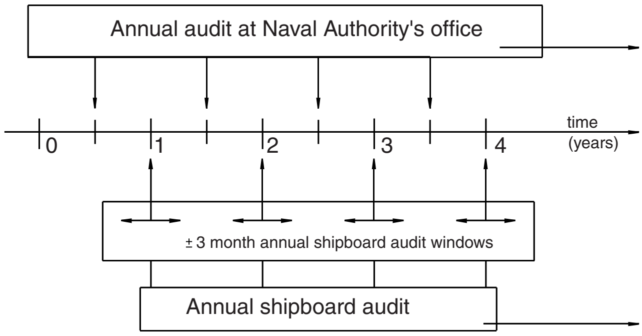
5 Maintenance of the notation

5.1 Annual audit at the Naval Authority's offices

5.1.1 The audit is to be carried out annually preferably within the prescribed six-month window as shown in Fig 1.

If more than one ship belonging to the same Owner are assigned the **STAR-MACH** notation, this annual audit may be performed for all ships at the same time at a suitable period agreed between the Owner and the Society.

Figure 1 : Audit periodicity



5.1.2 The Surveyor checks that the ship data base held at Owner's office is kept updated, in particular with the inspection and maintenance reports of the Inspection and Maintenance Plan.

From the data collected during this audit and data received from the ship, a preliminary review is done. This review may lead to extending the scope of the audit and/or an occasional machinery survey on board the ship, specifically for machinery the performance of which is deteriorating. The audit includes the examination of:

- preventive maintenance records
- corrective maintenance records
- predictive maintenance records, that is, planning records about outstanding inspections or other actions for the forthcoming period.

5.2 Annual shipboard audit

5.2.1 The annual shipboard audit is to be carried out concurrently with the annual survey.

5.2.2 During this audit the Surveyor:

- verifies that the ship data base is kept updated and transmitted to the Owner's office
- verifies the consistency and implementation of the Inspection and Maintenance Plan
- carries out additional inspections and/or tests relevant to machinery, if required as a result of the audit at the Owner's office.

5.3 Occasional onboard audits and/or surveys

5.3.1 Occasional audits may be required after audits at the Owner's offices that showed the Inspection and Maintenance Plan has not been applied or working in the manner intended, or that particular equipment showed abnormal behaviour.

5.3.2 The Society is to be notified when an item is due to be repaired on a non-scheduled basis because of failure. The notification is to include the place, time and specification of the corrective action which has to be executed. The Society will decide whether to carry out an occasional on board survey.

5.3.3 Changes to the operation of the ship and/or modifications to machinery and/or equipment are to be notified to the Society, so that:

- a survey onboard the ship may be carried out to verify the changes and modifications
- the effects of the changes and modifications could be taken into consideration, if deemed necessary, during the next risk analysis
- an immediate revision of the Inspection and Maintenance Plan is conducted, if deemed necessary.

The effects of any changes in relation to the Inspection and Maintenance Plan are monitored during the next annual shipboard audit.

5.4 Suspension and withdrawal of the notation

5.4.1 The maintenance of the **STAR-MACH** notation is subject to the same principles as those for the maintenance of class: surveys are to be carried out by their limit dates, possible recommendations (related to the notation) are to be dealt with by their limit dates.

The suspension of class automatically causes the suspension of the **STAR-MACH** notation.

5.4.2 Different events may lead either to imposition of a recommendation related to the **STAR-MACH** notation or to suspension of the notation itself. Some cases are given below:

a) The condition of the machinery installations is below the minimum level required for class. The action to be taken is either the immediate repair or the imposition of a recommendation for class (if acceptable) and suspension of the **STAR-MACH** notation. However, in cases where the recommendation is of a minor nature, the notation may not be suspended.

b) The Inspection and Maintenance Plan is not complied with (e.g. delays in performing the operations programmed according to the plan or the scope of inspection and/or maintenance not completely fulfilled), and/or the maintenance of the data base is not fulfilled.

   The action to be taken is:

   - either the immediate compliance with the requirements or the imposition of a recommendation, if the non-conformity is of a minor nature or is an exceptional occurrence, or
   - the suspension of the **STAR-MACH** notation, if the non-conformity is of a major nature or a recurrence.

c) A defect or a deficiency is found in applying the Inspection and Maintenance Plan. The actions to be taken are the same as stated above both for repair of machinery installations (case a) above) and for the application of the Inspection and Maintenance Plan (case b)).

d) An unexpected defect or deficiency is found or a casualty occurs, i.e. not as a result of lack of maintenance or failure in the application of the Inspection and Maintenance Plan. The actions to be taken are the same as stated in the case a) above.

5.4.3 The withdrawal of the **STAR-MACH** notation may be decided in different cases, such as:

- recurrent suspension of the **STAR-MACH** notation
- suspension of the **STAR-MACH** notation for more than a given period (i.e. 3 months)
- expiry or withdrawal of class.

Appendix 1 Acceptance Criteria for Isolated Areas of Items

1 General

1.1 Application

1.1.1 The acceptance criteria consist in checking that the thickness diminution of an isolated area of an item (measured according to Ch 2, Sec 1, [4.3.2]) is less than the acceptable limits specified in [1.1.2]. Otherwise, actions according to Ch 2, Sec 1, [4.3.2] are to be taken.

1.1.2 The acceptable limits for the thickness diminution of isolated areas of items contributing to the hull girder longitudinal strength are specified in:

- Tab 1 for the bottom zone items
- Tab 2 for the neutral axis zone items
- Tab 3 for the deck zone items.

The acceptable limits for the thickness diminution of isolated areas of items not contributing to the hull girder longitudinal strength are specified in Tab 4.

Table 1 : Acceptable limits for the thickness diminution of isolated areas of items
Items contributing to the hull girder longitudinal strength and located in the bottom zone

Item			Acceptance limit
Plating of:	• keel, bottom and bilge • inner bottom • lower strake of longitudinal bulkheads		18%
Longitudinal ordinary stiffeners of:	• keel, bottom and bilge • inner bottom • lower strake of longitudinal bulkheads	web	18%
		flange	15%
Longitudinal primary supporting members		web	18%
		flange	15%

Table 2 : Acceptable limits for the thickness diminution of isolated areas of items
Items contributing to the hull girder longitudinal strength and located in the neutral axis zone

Item			Acceptance limit
Plating of:	• side • longitudinal bulkheads • decks		18%
Longitudinals ordinary stiffeners of:	• side • longitudinal bulkheads • decks	web	18%
		flange	15%
Longitudinal primary supporting members		web	18%
		flange	15%

Table 3 : Acceptable limits for the thickness diminution of isolated areas of items
Items contributing to the hull girder longitudinal strength and located in the deck zone

Item			Acceptance limit
Plating of:	• upper deck, stringer plate and sheerstrake • upper strake of longitudinal bulkheads		18%
Longitudinal ordinary stiffeners of:	• upper deck, stringer plate and sheerstrake • upper strake of longitudinal bulkheads	web	18%
		flange	15%
Longitudinal primary supporting members		web	18%
		flange	15%

Table 4 : Acceptable limits for the thickness diminution of isolated areas of items Items not contributing to the hull girder longitudinal strength

Item		Acceptance limit
Hatch coamings	plating	18%
	brackets	22%
Hatch covers	top plating	18%
	side and end plating	18%
	ordinary stiffeners	18%
Plating of transverse bulkheads		18%
Ordinary stiffeners of transverse bulkheads	web	22%
	flange	18%
	brackets	22%
Vertical primary supporting members and horizontal girders of bulkheads	web	18%
	flange	15%
	brackets /stiffeners	18%
Side frames	web	18%
	flange	15%
	brackets / stiffeners	18%
Deck and bottom transverse primary supporting members	web	18%
	flange	15%
	brackets	18%
Plating of the forward and aft peak bulkheads		18%
Ordinary stiffeners of the forward and aft peak bulkheads	web	22%
	flange	18%

Appendix 2 Acceptance Criteria for Isolated Items

Symbols

t_A : As-built thickness of plating, in mm

t_M : Measured thickness of plating, in mm

t_C : Corrosion additions, in mm, defined in Pt B, Ch 4, Sec 2, [3]

t_{C1}, t_{C2} : Corrosion additions, in mm, defined in Pt B, Ch 4, Sec 2, [3] for the two compartments separated by the plating under consideration. For plating internal to a compartment, $t_{C1} = t_{C2} = t_C$

t_R : Overall renewal thickness, in mm, of plating, in mm, defined in:

- [2.2.1] in general
- [4.3.1] for the plating which constitutes primary supporting members

t_{R1} : Minimum renewal thickness, in mm, of plating defined in [2.2.2]

t_{R2} : Renewal thickness, in mm, of plating subjected to lateral pressure or wheeled loads, i.e. the thickness that the plating of a ship in service is to have in order to fulfil the strength check. This thickness is to be calculated as specified in [2.2.3]

t_{R3} : Compression buckling renewal thickness, in mm, i.e. the thickness that the plating of a ship in service is to have in order to fulfil the compression buckling check. This thickness is to be calculated as specified in [2.2.4]

t_{R4} : Shear buckling renewal thickness, in mm, i.e. the thickness that the plating of a ship in service is to have in order to fulfil the shear buckling check. This thickness is to be considered only for ships equal to or greater than 90 m in length and is to be calculated as specified in [2.2.5]

t_G : Rule gross thickness, in mm, of plating, defined in [2.2.6]

$t_{A,W}$: As built thickness of ordinary stiffener web, in mm

$t_{A,F}$: As built thickness of ordinary stiffener face plate, in mm

$t_{M,W}$: Measured thickness of ordinary stiffener web, in mm

$t_{M,F}$: Measured thickness of ordinary stiffener face plate, in mm

w_M : Section modulus, in cm^3, of ordinary stiffeners, to be calculated on the basis of the measured thicknesses of web, face plate and attached plating

w_R : Renewal section modulus, in cm^3, of ordinary stiffeners i.e. the section modulus that an ordinary stiffener of a ship in service is to have to fulfil the yielding check.

$t_{R,W}$: Renewal thickness, in mm, of ordinary stiffener web, i.e. the web thickness that an ordinary stiffener of a ship in service is to have in order to fulfil the buckling check. This thickness is to be calculated as specified in [3.2.2]

$t_{R,F}$: Renewal thickness, in mm, of ordinary stiffener face plate, i.e. the face plate thickness that an ordinary stiffener of a ship in service is to have in order to fulfil the buckling check. This thickness is to be calculated as specified in [3.2.2]

w_G : Rule gross section modulus, in cm^3, of ordinary stiffeners, defined in [3.2.3]

WR_R : Re-assessment work ratio, defined in [4.2.1]

WR_A : As-built work ratio, defined in [4.2.2]

t_{RY} : Yielding renewal thickness, in mm, of primary supporting members, i.e. the thickness that the plating which constitutes primary supporting members of a ship in service is to have in order to fulfil the yielding check. This thickness is to be calculated as specified in [4.3.2]

t_{RB} : Buckling renewal thickness, in mm, of primary supporting members, i.e. the thickness that the plating which constitutes primary supporting members of a ship in service is to have in order to fulfil the buckling check. This thickness is to be calculated as specified in [4.3.3]

E : Young's modulus, in N/mm^2, to be taken equal to:

- for steels in general: $E = 2,06.10^5$ N/mm^2
- for stainless steels: $E = 1,93.10^5$ N/mm^2

ν : Poisson's ratio. Unless otherwise specified, a value of 0,3 is to be taken into account

R_{eH} : Minimum yield stress, in N/mm^2, of the material, defined in Pt B, Ch 4, Sec 1, [2]

γ_m, γ_R, γ_{K1}, ... , γ_{K9} : Partial safety factors, defined in [1].

1 Partial safety factors

1.1 General

1.1.1 The partial safety factors γ_m and γ_R are defined in:

- Pt B, Ch 7, Sec 1, [1.2] for plating
- Pt B, Ch 7, Sec 2, [1.2] for ordinary stiffeners
- Pt B, Ch 7, Sec 3, [1.3] for primary supporting members.

1.2 Partial safety factors based on the increased knowledge of the structure

1.2.1 General

The partial safety factors γ_{K1}, γ_{K2}, το γ_{K9} take into account the increased knowledge of the structural behaviour obtained through the surveys carried out on in-service ship structures and verification of their performances. Therefore, they have values equal to or less than 1,0 and apply to reduce the partial safety factor on resistance, γ_R, adopted in the strength checks of new ships (see Part B, Chapter 7.

1.2.2 Partial safety factors γ_{K1}, γ_{K2}, γ_{K3} and γ_{K4} for plating

These partial safety factors are to be calculated as specified in:

- [2.2.2] for minimum thicknesses (γ_{K1})
- [2.2.3] for the strength checks of plate panels subjected to lateral pressure or wheeled loads (γ_{K2})
- [2.2.4] for the compression buckling strength checks (γ_{K3})
- [2.2.5] for the shear buckling strength checks (γ_{K4}).

1.2.3 Partial safety factor γ_{K5} for ordinary stiffeners

The partial safety factor for yielding checks of ordinary stiffeners (γ_{K5}) is to be calculated as specified in [3.2.1].

1.2.4 Partial safety factors γ_{K6}, γ_{K7}, γ_{K8} and γ_{K9} for primary supporting members

These partial safety factors are to be calculated as specified in:

- [4.2.1] for reassessment structural analyses (γ_{K6}, γ_{K7})
- [4.3.2] for yielding strength checks (γ_{K8})
- [4.3.3] for buckling strength checks (γ_{K9}).

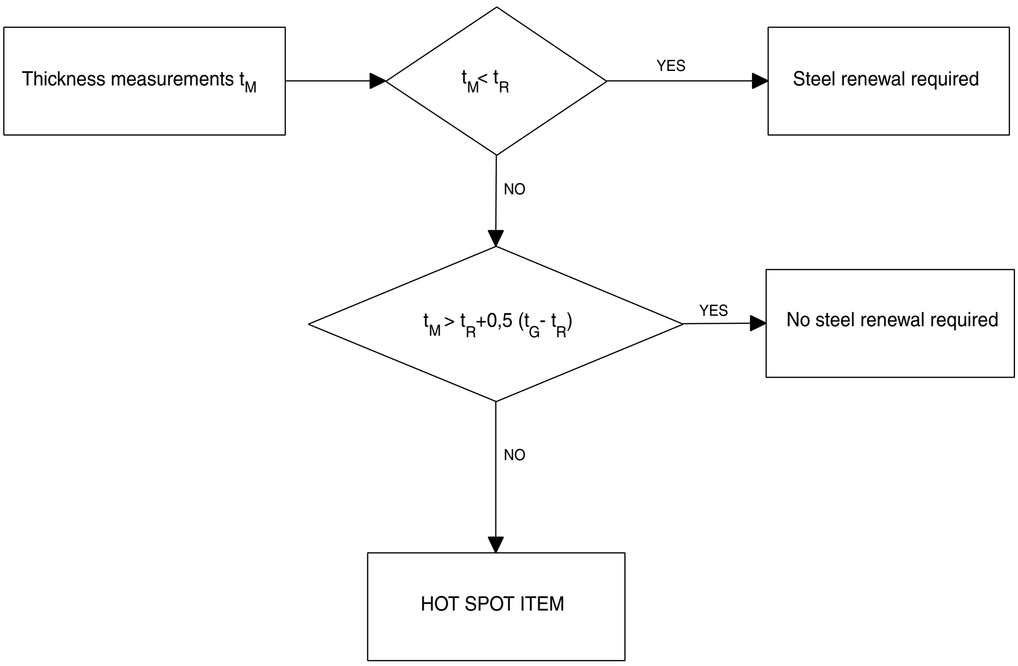
2 Acceptance criteria for plating

2.1 Application

2.1.1 General

The acceptance criteria for measured thicknesses of plating, together with the application procedure to be adopted during the reassessment of hull structures, are indicated in Fig 1.

Figure 1 : Acceptance criteria for measured thicknesses of plating and application procedure



2.2 Renewal thicknesses

2.2.1 Overall renewal thickness

The overall renewal thickness is to be obtained, in mm, from the following formula:

$t_R = \max(t_{R1}, t_{R2}, t_{R3}, t_{R4})$

2.2.2 Minimum renewal thickness

The minimum renewal thickness is to be obtained, in mm, from the following formula:

$t_{R1} = t_1 \gamma_{K1}$

where:

t_1 : Minimum net thickness, in mm, to be calculated as specified in Pt B, Ch 7, Sec 1, [2.2]

γ_{K1} : Partial safety factor: $\gamma_{K1} = N_P \Psi_1$ without being taken greater than 1,0

N_p : Coefficient defined in Tab 1

$$\Psi_1 = 1 + \frac{t_{C1} + t_{C2}}{t_1}$$

Table 1 : Coefficient N_P

Plating	Coefficient N_P
In general, including that which constitutes web of primary supporting members	0,85
Plating which constitutes face plate of primary supporting members	0,89

2.2.3 Renewal thickness of plating subjected to lateral pressure or wheeled loads

The renewal thickness of plating subjected to lateral pressure or wheeled loads is to be obtained, in mm, from the following formula:

$t_{R2} = t_2 \gamma_{K2}$

where:

t_2 : Net thickness, in mm, to be calculated as specified in:

- Pt B, Ch 7, Sec 1, [3], as applicable, for plating subjected to lateral pressure
- Pt B, Ch 7, Sec 1, [4], as applicable, for plating subjected to wheeled loads

where the hull girder stresses are to be calculated considering the hull girder transverse sections constituted by elements (plating, ordinary stiffeners, primary supporting members) having their measured thicknesses and scantlings

γ_{K2} : Partial safety factor: $\gamma_{K2} = N_P \Psi_2$ without being taken greater than 1,0

N_p : Coefficient defined in Tab 1

$$\Psi_2 = 1 + \frac{t_{C1} + t_{C2}}{t_2}$$

2.2.4 Compression buckling renewal thickness

The compression buckling renewal thickness is to be obtained, in mm, from the following formula:

$t_{R3} = t_3 \gamma_{K3}$

where:

t_3 : Net thickness to be obtained, in mm, from the following formulae:

$$t_3 = \frac{b}{\pi}\sqrt{\frac{\sigma_{x1}\gamma_R\gamma_m 12(1-\nu^2)}{EK_1\varepsilon}}10^3 \quad \text{for} \quad \gamma_m\gamma_R\sigma_{x1} \le \frac{R_{eH}}{2}$$

$$t_3 = \frac{b}{\pi}\sqrt{\frac{3(1-\nu^2)R_{eH}^2}{EK_1\varepsilon(R_{eH}-\sigma_{x1}\gamma_R\gamma_m)}}10^3 \quad \text{for} \quad \gamma_m\gamma_R\sigma_{x1} > \frac{R_{eH}}{2}$$

b : Length, in m, of the plate panel side, defined in Pt B, Ch 7, Sec 1, [5.1.2]

σ_{x1} : In plane hull girder normal stress, in N/mm² to be calculated as specified in Pt B, Ch 7, Sec 1, [5.2.2], considering the hull girder transverse sections as being constituted by elements (plating, ordinary stiffeners, primary supporting members) having their measured thicknesses and scantlings

ε, K_1 : Coefficients defined in Pt B, Ch 7, Sec 1, [5.3.1]

γ_{K3} : Partial safety factor: $\gamma_{K3} = N_P \Psi_3$ without being taken greater than 1,0

N_p : Coefficient defined in Tab 1

$$\Psi_3 = 1 + \frac{t_{C1} + t_{C2}}{t_3}$$

2.2.5 Shear buckling renewal thickness

The shear buckling renewal thickness is to be obtained, in mm, from the following formula:

$t_{R4} = t_4 \gamma_{K4}$

where:

t_4 : Net thickness to be obtained, in mm, from the following formulae:

$$t_4 = \frac{b}{\pi}\sqrt{\frac{\tau_1\gamma_R\gamma_m 12(1-\nu^2)}{EK_2}}10^3 \quad \text{for} \quad \gamma_m\gamma_R\tau_1 \le \frac{R_{eH}}{2\sqrt{3}}$$

$$t_4 = \frac{b}{\pi}\sqrt{\frac{\sqrt{3}(1-\nu^2)R_{eH}^2}{EK_2(R_{eH}-\sqrt{3}\tau_1\gamma_R\gamma_m)}}10^3 \quad \text{for} \quad \gamma_m\gamma_R\tau_1 > \frac{R_{eH}}{2\sqrt{3}}$$

b : Length, in m, of the plate panel side, defined in Pt B, Ch 7, Sec 1, [5.1.3]

τ_1 : In plane hull girder shear stress, in N/mm², to be calculated as specified in Pt B, Ch 7, Sec 1, [5.2.3], considering the hull girder transverse sections as being constituted by elements (plating, ordinary stiffeners, primary supporting members) having their measured thicknesses and scantlings

K_2 : Coefficient defined in Pt B, Ch 7, Sec 1, [5.3.2]

γ_{K4} : Partial safety factor: $\gamma_{K4} = N_P \Psi_4$ without being taken greater than 1,0

N_p : Coefficient defined in Tab 1

$$\Psi_4 = 1 + \frac{t_{C1} + t_{C2}}{t_4}$$

2.2.6 Rule gross thickness

The rule gross thickness is to be obtained, in mm, from the following formula:

$t_G = \max(t_1, t_2, t_3, t_4) + t_{c1} + t_{c2}$

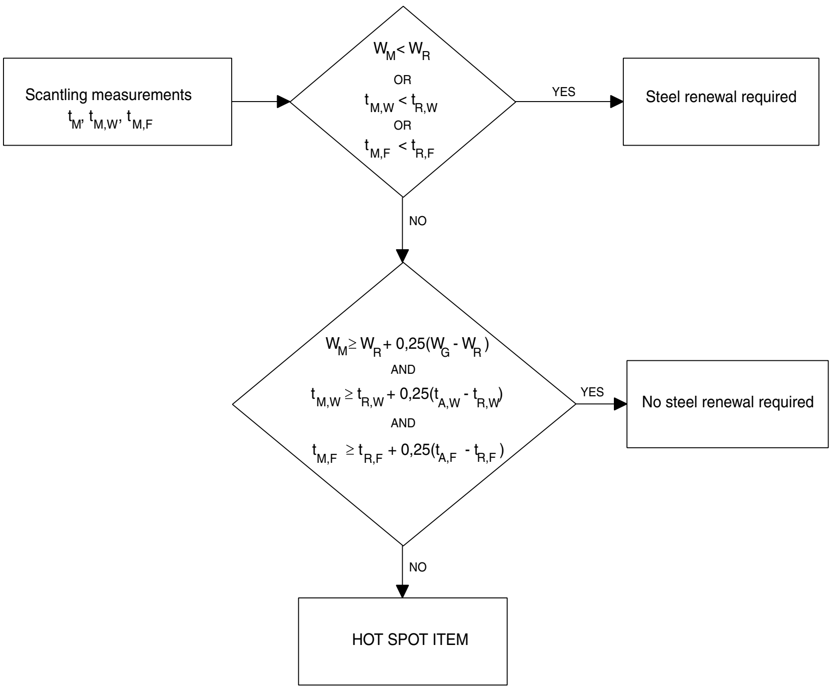
where t_1, t_2, t_3 and t_4 are the net thicknesses defined in [2.2.2], [2.2.3], [2.2.4] and [2.2.5], respectively.

3 Acceptance criteria for ordinary stiffeners

3.1 Application

3.1.1 The acceptance criteria for measured scantlings of ordinary stiffeners, together with the application procedure to be adopted during the reassessment of hull structures, are indicated in Fig 2.

Figure 2 : Acceptance criteria for measured scantlings of ordinary stiffeners and application procedure



3.2 Renewal scantlings

3.2.1 Renewal section modulus

The renewal section modulus is to be obtained, in cm^3, from the following formula:

$w_R = w_Y \gamma_{K5}$

where:

w_Y : Net section modulus, in cm^3, to be calculated as specified in Pt B, Ch 7, Sec 2, [3], where the hull girder stresses are to be calculated considering the hull girder transverse sections constituted by elements (plating, ordinary stiffeners, primary supporting members) having their measured thicknesses and scantlings

γ_{K5} : Partial safety factor: $\gamma_{K5} = N_S \Psi_5$ without being taken greater than 1,0

N_S : Coefficient defined in Tab 2

$$\Psi_5 = \frac{1 + \frac{\beta t_C}{w_Y}}{1 - \alpha t_C}$$

α, β : Parameters, depending on the type of ordinary stiffener, defined in Pt B, Ch 4, Sec 2, Tab 1.

Table 2 : Coefficient N_S

Ordinary stiffeners	N_S
Flat bars and bulb profiles	0,85
Flanged profiles	0,81

3.2.2 Renewal web and face plate thicknesses

The renewal web and face plate thicknesses are to be obtained, in mm, from the following formulae:

$t_{R,W} = h_W / C_W$

$t_{R,F} = b_F / C_F$

where:

h_w : Web height, in mm

b_f : Face plate breadth, in mm

C_W, C_F : Coefficients depending on the type and material of ordinary stiffeners, defined in Tab 3.

In any case, the renewal web and face plate thicknesses are to be not less than those obtained according to Pt A, Ch 2, App 3, [4], considering a maximum percentage of wastage equal to 0,75 times the relevant values there specified.

3.2.3 Rule gross section modulus

The rule gross section modulus is to be obtained, in cm^3, from the following formula:

$$w_G = \frac{w_Y + \beta t_C}{1 - \alpha t_C}$$

where:

α, β : Parameters, depending on the type of ordinary stiffener, defined in Pt B, Ch 4, Sec 2, Tab 1

w_Y : Net section modulus, in cm^3, defined in [3.2.1].

Table 3 : Coefficients C_W and C_F

Type of ordinary stiffeners	C_W			C_F		
	R_{eH} = 235 N/mm^2	R_{eH} = 315 N/mm^2	R_{eH} = 355 N/mm^2	R_{eH} = 235 N/mm^2	R_{eH} = 315 N/mm^2	R_{eH} = 355 N/mm^2
Flat bar	20	18	17,5	Not applicable		
Bulb	56	51	49	Not applicable		
With symmetrical face plate	56	51	49	34	30	29
With non-symmetrical face plate	56	51	49	17	15	14,5

4 Acceptance criteria for primary supporting members

4.1 Application

4.1.1 The acceptance criteria for measured scantlings of primary supporting members, together with the application procedure to be adopted during the reassessment of hull structures, are indicated in Fig 3.

4.2 Work ratios

4.2.1 Reassessment work ratio

The reassessment work ratio is to be obtained from the following formula:

$WR_R = \max (\gamma_{K6} WR_Y, \gamma_{K7} WR_B)$

where:

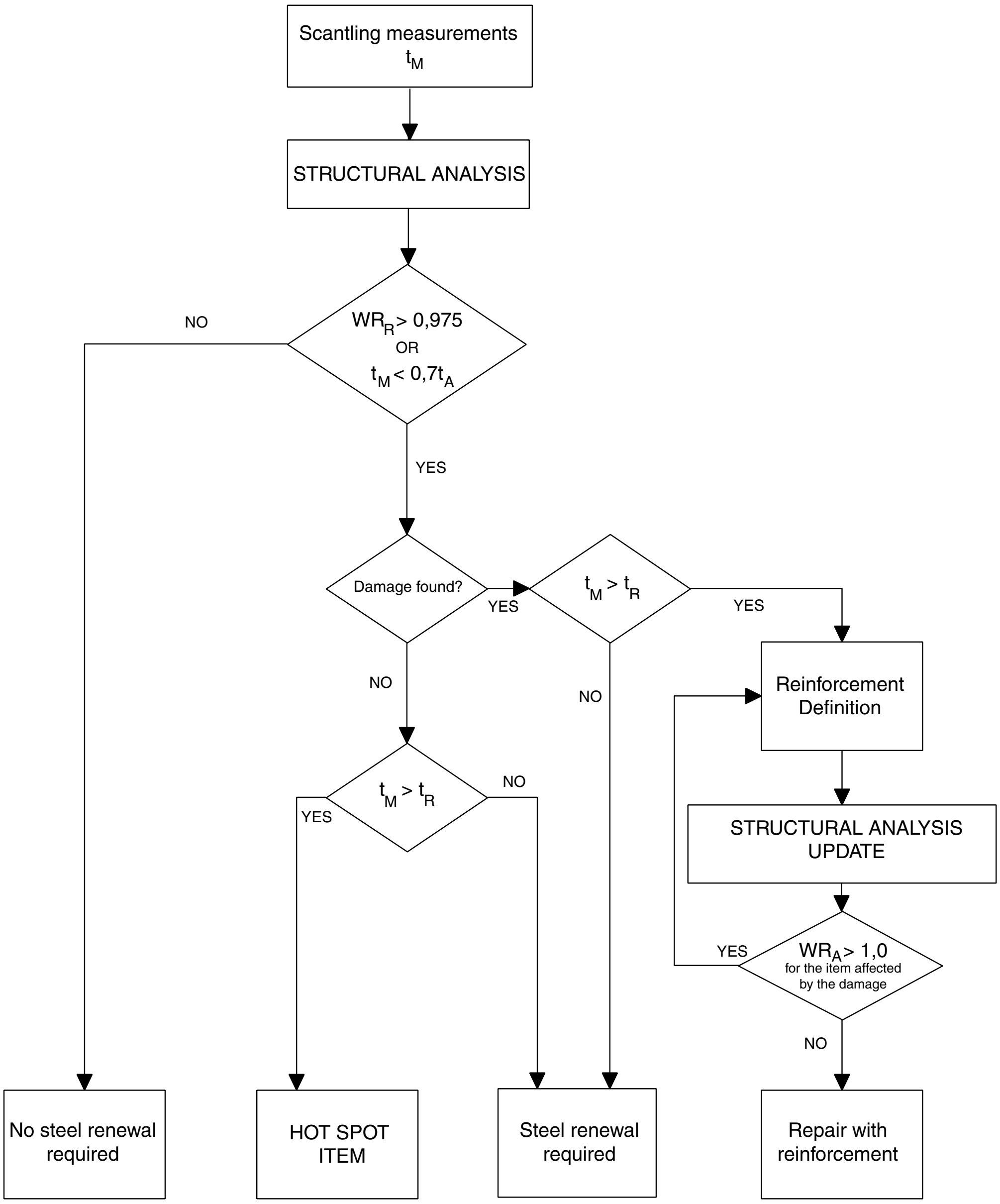
γ_{K6} : Partial safety factor: $\gamma_{K6} = 0,85$

γ_{K7} : Partial safety factor: $\gamma_{K7} = 1,00$

WR_Y : Yielding work ratio, defined in [4.2.3]

WR_B : Buckling work ratio, defined in [4.2.4].

Figure 3 : Acceptance criteria for measured scantlings of primary supporting members and application procedure



4.2.2 As-built work ratio

The as-built work ratio is to be obtained from the following formula:

$WR_A = \max (WR_Y, WR_B)$

where:

WR_Y : Yielding work ratio, defined in [4.2.3]

WR_B : Buckling work ratio, defined in [4.2.4].

4.2.3 Yielding work ratio

The yielding work ratio is to be obtained from the following formula:

$$WR_Y = \frac{\gamma_R \gamma_m \sigma_{VM}}{R_y}$$

where:

σ_{VM} : Equivalent stress, in N/mm², to be calculated as specified in Pt B, Ch 7, App 1, [5.1.2], considering the hull structure as being constituted by elements (plating, ordinary stiffeners, primary supporting members) having their measured thicknesses and scantlings

R_y : Minimum yield stress, in N/mm², of the material, to be taken equal to 235/k N/mm²

k : Material factor, defined in Pt B, Ch 4, Sec 1, [2.3].

4.2.4 Buckling work ratio

The buckling element work ratio is to be obtained from the following formula:

$WR_B = \max (WR_{B1}, WR_{B2}, WR_{B3}, WR_{B4})$

where:

WR_{B1} : Compression buckling work ratio:

$$WR_{B1} = \frac{\gamma_R \gamma_m \sigma_b}{\sigma_c}$$

WR_{B2} : Shear buckling work ratio:

$$WR_{B2} = \frac{\gamma_R \gamma_m \tau_b}{\tau_c}$$

WR_{B3} : Compression, bending and shear buckling work ratio:

$$WR_{B3} = \frac{F}{F_c}$$

WR_{B4} : Bi-axial compression and shear buckling work ratio:

$$WR_{B4} = \gamma_R \gamma_m \left(\left(\frac{\sigma_a}{R_a \sigma_{c,a}} \right)^n + \left(\frac{\sigma_b}{R_b \sigma_{c,b}} \right)^n \right)^{\frac{1}{n}}$$

σ_a, σ_b, τ_b: Normal and shear stresses, in N/mm², defined in Pt B, Ch 7, Sec 1, [5.4]

σ_c, τ_c : Critical buckling stresses, in N/mm², defined in Pt B, Ch 7, Sec 1, [5.3]

F : Coefficient defined in Pt B, Ch 7, Sec 1, [5.4.4]

F_c : Coefficient to be obtained from the following formulae:

for $\dfrac{\sigma_{comb}}{F} \le \dfrac{R_{eH}}{2 \gamma_R \gamma_m}$:

$$F_c = 1$$

for $\dfrac{\sigma_{comb}}{F} > \dfrac{R_{eH}}{2 \gamma_R \gamma_m}$:

$$F_c = \frac{4 \sigma_{comb}}{R_{eH} / \gamma_R \gamma_m} \left(1 - \frac{\sigma_{comb}}{R_{eH} / \gamma_R \gamma_m} \right)$$

σ_{comb} : Combined stress in N/mm², defined in Pt B, Ch 7, Sec 1, [5.4.4]

$\sigma_{c,a}$, $\sigma_{c,b}$: Critical buckling stresses, in N/mm², defined in Pt B, Ch 7, Sec 1, [5.4.5]

n, R_a, R_b : Coefficients defined in Pt B, Ch 7, Sec 1, [5.4.5].

The above quantities are to be calculated considering the hull structure as being constituted by elements (plating, ordinary stiffeners, primary supporting members) having their measured thicknesses and scantlings.

4.3 Renewal scantlings

4.3.1 Overall renewal thickness

The overall renewal thickness is to be obtained, in mm, from the following formula:

$t_R = \max (t_{RY}, t_{RB}, 0{,}75 t_A)$

4.3.2 Yielding renewal thickness

The yielding renewal thickness is to be obtained, in mm, from the following formula:

$t_{RY} = t_Y \gamma_{K8}$

where:

t_Y : Net thickness to be obtained, in mm, from the following formula: $t_Y = [t_A - 0,5\ (t_{C1} + t_{C2})]\ WR_Y$

WR_Y : Yielding work ratio, defined in [4.2.3]

γ_{K8} : Partial safety factor: $\gamma_{K8} = N_P\ \Psi_Y$

N_p : Coefficient defined in Tab 1

$$\Psi_Y = 1 + \frac{0,25(t_{C1} + t_{C2})}{t_Y}$$

4.3.3 Buckling renewal thickness

The buckling renewal thickness is to be obtained, in mm, from the following formula:

$t_{RB} = t_B \gamma_{K9}$

where:

t_B : Net thickness to be obtained, in mm, from the following formula:

$$t_B = [t_A - 0,5(t_{C1} + t_{C2})]\sqrt[3]{WR_B}$$

WR_B : Buckling work ratio, defined in [4.2.4]

γ_{K9} : Partial safety factor: $\gamma_{K9} = N_P\ \Psi_B$

N_p : Coefficient defined in Tab 1

$$\Psi_B = 1 + \frac{0,25(t_{C1} + t_{C2})}{t_B}$$

Appendix 3 Acceptance Criteria for Zones

1 General

1.1 Application

1.1.1 The acceptance criteria consist in checking that the sectional area diminution of a zone (measured according to Ch 2, Sec 1, [4.3.4]) is less than the acceptable limits specified in [1.1.2]. Otherwise, actions according to Ch 2, Sec 1, [4.3.4] are to be taken.

1.1.2 The acceptable limits for the sectional area diminution of zones are specified in Tab 1.

Table 1 : Acceptable limits for the sectional area diminution of zones

Zone		Acceptable limit
Bottom zone		7%
Neutral axis zone	Side	11%
	Inner side and longitudinal bulkheads	11%
Deck zone		7%

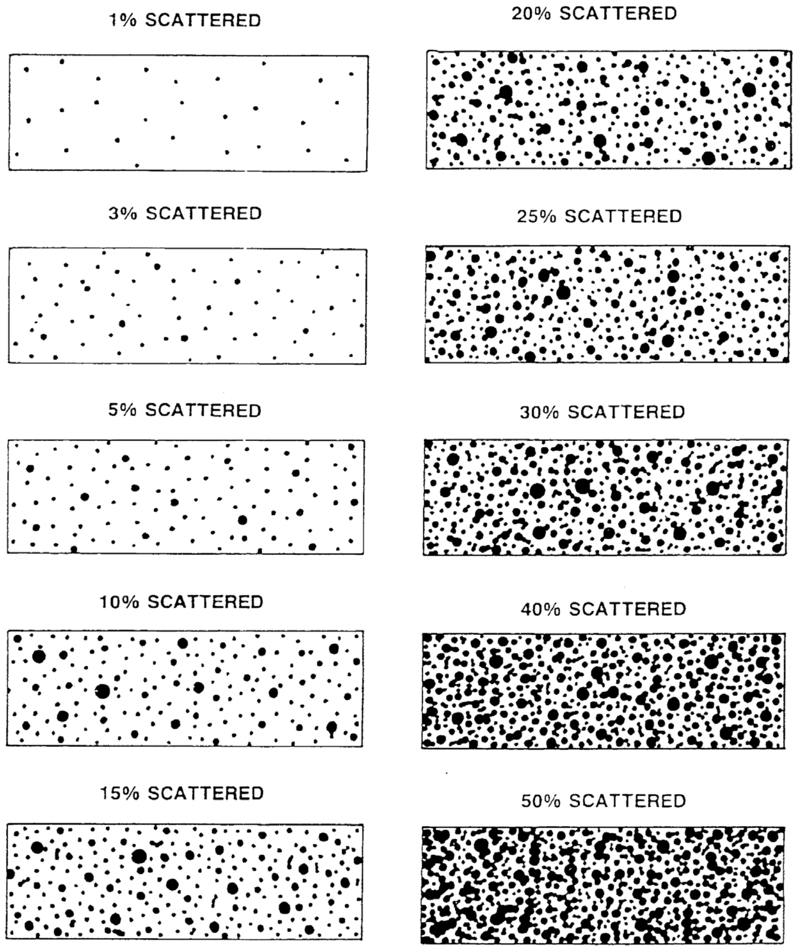
Appendix 4 Pitting Intensity Diagrams

1 General

1.1 Diagrams

1.1.1 As specified in Ch 2, Sec 1, [4.4.1], the pitting intensity is defined by the percentage of area affected by pitting. In order to define the area affected by pitting, and thus the pitting intensity, the diagrams in Fig 1 are to be used.

Figure 1 : Pitting intensity diagrams (from 1% to 50% intensity)



Appendix 5 Naval Authority's Hull Inspection Reports

1 General

1.1

1.1.1 Application

As stated in Ch 2, Sec 1, [3.5], inspection reports are to be prepared by the Naval Authority's person responsible each time an inspection is carried out within the scope of the Inspection and Maintenance Plan. Two models of inspection report are provided for this purpose:

- one model for inspection of spaces (applicable to inspection of deck area structure, ballast tanks, dry holds and spaces, superstructures and other accessible compartments)
- one model for inspection of hull equipment (applicable to hatches, deck equipment, sea connections and overboard discharges).

One separate inspection report is to be issued for each different space or equipment inspected.

1.1.2 Use of models

The Naval Authority is to adapt these models, so far as practicable and appropriate, to the ship concerned, the spaces to be inspected and the existing equipment. However, the general content of the report and its layout are to comply with the models.

1.1.3 Ship database

Interested parties are reminded that, as stated in Ch 2, Sec 1, [1.3], the inspection reports are to be processed and recorded in the ship database which is to be installed on board ship and at the Naval Authority's offices. Therefore, these models are to be used as a guide for entering the collected data into the ship database, in an electronic form.

The recording in the ship database is to be such as to easily retrieve the different reports pertaining the same spaces and equipment during the lifetime of the ship, or the reports of inspections performed during a given period, or the reports related to the same type of space or equipment.

The attached documentation referred to in [2.5] and [3.4] may be either kept in a separate paper file or electronically processed in the ship database through appropriate means.

2 Report for inspection of spaces

2.1 General

2.1.1 The model of Naval Authority's report for space inspection is given in Tab 1.

2.1.2 The report is divided into four parts:

- general identification data
- summary of findings and repairs for the different areas of the space and for the fittings in this space
- details of findings and repairs, as applicable
- additional documentation attached to the report.

2.2 Identification data

2.2.1 The identification data are to give the information about the space inspected, date and place of inspection and name of the person under whose responsibility the inspection has been carried out.

2.2.2 The identification of the space is to be such that:

- it is easy to trace the space concerned, in particular in cases where several identical spaces exist on the ship
- the same identification is used for the subsequent inspection reports pertaining to the same space.

Table 1 : Naval Authority's report for space inspection

Person responsible:	
Date of inspection:	Place of inspection:
Name of ship:	Register number:
Name and type of space:	Location (port/stbd, from frame... to frame...):

Structure area, fittings	Items in the area	Coating / anode condition	Fractures	General corrosion	Pitting or grooving	Deformations	Repairs	Other
Top								
Bottom								
Port side								
Stbd side								
Forward bulkhead								
Aft bulkhead								
Internal structure								
Fittings								

Findings during inspection: (location, type, details)	Action taken: required repair, temporary repair, permanent repair (location, type and extent)
Other documentation attached to the report: sketches [ ] , photos [ ] , thickness measurement report [ ] , other [ ]	

2.3 Summary of findings and repairs

2.3.1 Each space inspected is divided into items corresponding to:

- the different boundaries of the space
- the internal structure of the space
- the fittings of the space.

For better understanding, the second column of the table may be used to clarify which elements belong to each item or which fittings are concerned.

2.3.2 For each item, as applicable, the summary table is to give a general answer to the findings and to the possible repairs made.

- When coating condition is concerned, the answer is to be either "no coating", or "good", or "fair", or "poor", as per the definition of such conditions given in Pt A, Ch 2, Sec 2.
- Anode condition is to be answered by giving an estimated average loss of weight as a percentage, bearing in mind the acceptance criteria given in Ch 2, Sec 1, [4].
- The other columns (fractures, general corrosion, pitting/grooving, deformations, repairs) are to be answered "yes" or "no", depending on whether or not such defect/repair has been found/performed.
- The column "other" is to be used to indicate whether another type of inspection has been carried out, such as thickness measurement, pressure test or working test.

2.4 Details of findings and repairs

2.4.1 Each time the answer in the summary table is "poor" for coating, or "yes" for other topics, this part of the report is to be used to give details on the findings, defects or repairs concerned.

2.4.2 As guidance, the following details are to be given:

- for coating found in poor condition: structural elements concerned, type of coating defect (breakdown, hard scale)
- for fractures: location of fractures, dimension, number of identical fractures
- for general corrosion: structural elements concerned, extent of wastage on these elements, estimation of wastage (if thickness measurements have been taken)
- for pitting/grooving: structural elements concerned and location, depth of pitting/grooving, percentage of affected surface using diagrams in Ch 2, App 4, length of grooving
- for deformations: type of deformation (buckling, external cause), location of the deformation and structural elements concerned, estimation of size
- for repairs (if performed without the attendance of a Surveyor, when this is possible or acceptable): type of repairs, elements or areas concerned.

2.5 Attached documentation

2.5.1 It is recommended that the report is supported by attaching sketches, photos, the thickness measurement report or other documentation, when this is deemed necessary to clarify the findings and/or repairs given in the detailed part.

For example:

- photos may be used to show the condition of the coating and anodes, the extent of general corrosion, pitting and grooving, or the appearance and extent of fractures
- sketches may be used to indicate fractures, deformations and repairs, especially when a photo cannot encompass the whole image and give a complete representation.

3 Report for inspection of equipment

3.1 General

3.1.1 The model of Naval Authority's report for equipment inspection is given in Tab 2.

3.1.2 The report is divided into three parts:

- general identification data
- detailed report of findings and repairs
- additional documentation attached to the report.

Table 2 : Naval Authority's report for equipment inspection

Person responsible:	
Date of inspection:	Place of inspection:
Name of ship:	Register number:
Name and type of equipment:	Location (port/stbd, at frame ..., ...):

Type of inspection, findings and readings:
Repairs, maintenance, pieces renewed:
Working tests, pressure test, trials,...:
Other documentation attached to the report: sketches [ ] , photos [ ] , thickness measurement report [ ] , other [ ]

3.2 Identification data

3.2.1 The identification data are to give the information about the equipment inspected, date and place of inspection and name of the person under whose responsibility the inspection has been carried out.

3.2.2 The identification of the equipment is to be such that:

- it is easy to trace the item of equipment concerned, in particular in cases where several identical items of equipment exist on the ship
- the same identification is used for the subsequent inspection reports pertaining to the same item of equipment.

3.3 Detailed report

3.3.1 The detailed report of inspection is divided into three parts:

- inspection done:
  - the type of inspection carried out: visual external examination, internal examination after dismantling, overhaul
  - readings performed, when applicable: clearances, thickness measurements, working pressure, or other working parameters of the equipment
  - findings during the inspection: corrosion, fractures, pieces of equipment worn out, broken or missing
- maintenance done, repairs carried out and pieces renewed
- results of tests performed after the inspection, such as working test, pressure test, hose test or equivalent for hatch covers or other weathertight fittings, sea trials.

3.4 Attached documentation

3.4.1 It is recommended that the report is supported by attaching sketches, photos, the thickness measurement report or other documentation, when this is deemed necessary to clarify the findings and/or repairs given in the detailed part.

For example:

- photos may be used to show the condition of the pieces of equipment before their overhaul or renewal, the coating condition of piping, or the extent of corrosion
- sketches may be used to indicate fractures and deformations, clearances taken, or other measurements performed.

Appendix 6 Risk Analyses for Star-Mach

1 General

1.1 Application

1.1.1 Scope

The scope of this appendix is to describe the procedure foreseen in order to carry out the risk analysis for the purpose of assigning and maintaining the **STAR-MACH** notation, as given in Ch 2, Sec 2.

The scope of the risk analysis is to identify critical systems and/or components, assess the Inspection and Maintenance Plan with regards to acceptable levels of risk and recommend measures to improve the type and/or periodicity of inspection and maintenance, when deemed necessary.

1.2 Carrying out of risk analysis

1.2.1 Initial risk analysis

An initial risk analysis is to be carried out by the Society, in accordance with Ch 2, Sec 2, [3.1.1].

1.2.2 Risk analysis review

The results of the initial risk analysis will be updated by the Society on the basis of the information and data gathered from the ship database, in accordance with Ch 2, Sec 2, [3.2.1].

1.3 Procedure

1.3.1 Definitions

a) Accident is defined as an event or a series of events whose consequence is loss of life, injury, ship loss or damage, or environmental damage.

b) Risk is defined as the combination of the probability and consequence of an accident.

c) Top event is defined as the final outcome of an event or a series of events (e.g. loss of propulsion).

d) Critical is a system and/or component whose failure may result in the loss of an essential ship's function (e.g. main propulsion system).

e) Fault Tree Analysis (FTA) is a logic diagram showing the causal relationship between events which singly or in combination may cause the occurrence of a top event. If two or more events need to occur to cause the next higher event, this is shown by a logic "and" gate. If any one of two or more events can cause the next higher event, this is shown by a logic "or" gate.

f) Event Tree Analysis (ETA) is a logic diagram used to analyse the effects of an accident, failure or unintended event, taking into account those actions which may mitigate or prevent their escalation. The probabilities of success or failure of each action, multiplied by the likelihood of the accident, gives the likelihood of each consequence.

g) Failure Mode and Effect Analysis (FMEA) is a technique to analyse the modes and consequences of a single failure of a component in a system. The effects of each single failure are analysed to determine their severity and possible mitigation with respect to the loss of the system as a whole.

h) Montecarlo simulation is a technique used to obtain statistical results about the outcome of a system, by means of random extractions of samples in a statistical population.

1.3.2 Flow-chart

Each step of the procedure is indicated in Fig 1 and described in the following paragraphs.

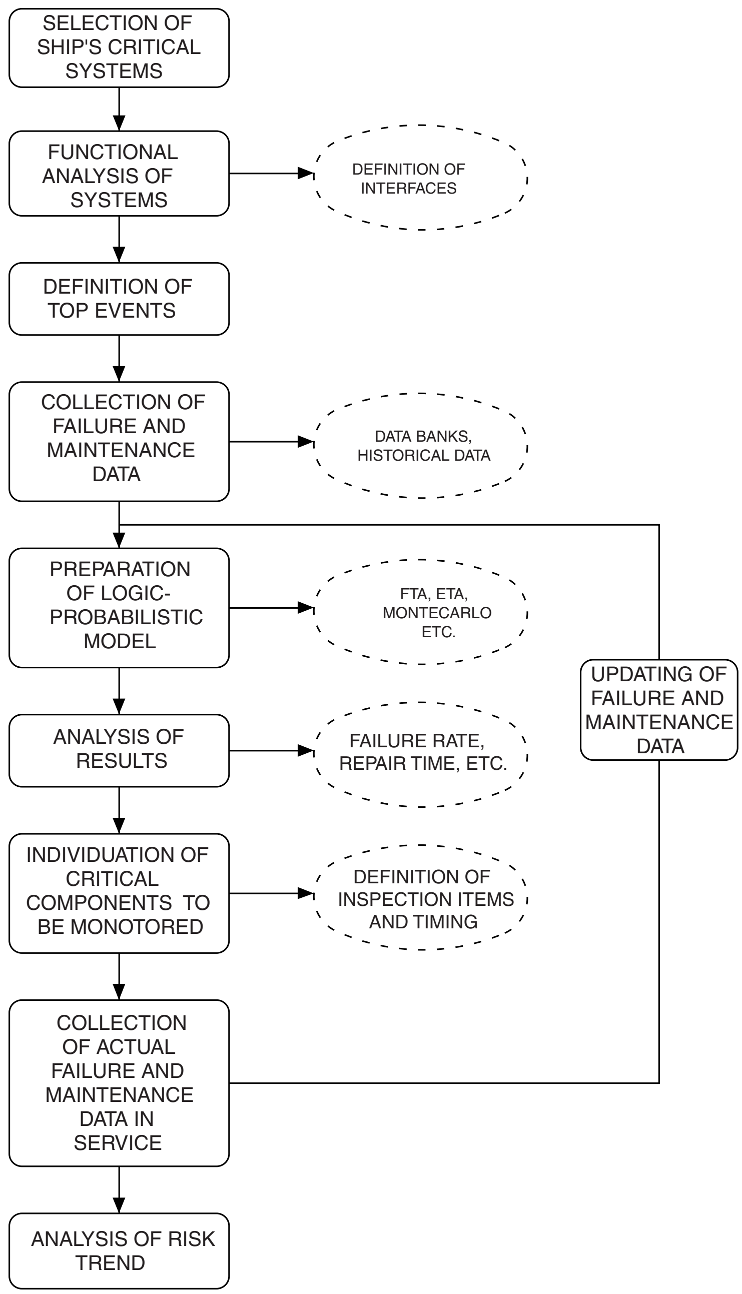
2 Overall process

2.1 Selection of the ship's critical systems

2.1.1 The first step of the risk analysis is to pre-select a list of systems and/or components which may become critical for the safety and operation of the ship.

The selected systems and components are to include at least the ones listed in Ch 2, Sec 2, Tab 1.

Figure 1 : Risk analysis overall process



2.1.2 The risk analysis is extended to other systems and/or components which are deemed critical from the point of view of safety and operation of the ship, depending on her declared mission.

2.2 Functional analysis of the systems

2.2.1 The selected critical systems and components are analysed in order to identify the functions performed by each of them during normal operations and in the case of emergency. For instance, the functions include propulsion, manoeuvrability, fire prevention, detection and alarm, etc.

The functions and systems are broken down to a level of detail which is appropriate for the results to be expected from the risk analysis. Aspects relevant to the interaction of the functions and systems are taken into particular consideration, in order to identify possible weak points, e.g. functions carried out by a single component whose failure may impair the availability of the whole system.

2.3 Definition of top events

2.3.1 This step is relevant to the definition of the top events which may lead to an accident. Examples of top events are:

- loss of propulsion
- loss of electric generation
- loss of steering capability, etc.

2.4 Collection of failure and maintenance data

2.4.1 The availability of failure and maintenance data relevant to the functions and systems under consideration is an important step of the risk analysis. Examples of useful statistical data are the mean time between failures (MTBF) and the mean time to repair (MTTR).

Such statistical data can be obtained from:

- the ship database (see Ch 2, Sec 2, [1.3]) with data recorded from the ship under consideration or similar ships of the same Naval Authority, when available
- historical data on similar installations
- data released by the Manufacturer
- data banks.

2.5 Preparation of the logic-probabilistic model

2.5.1 A logic-probabilistic model is defined for each selected system in order to establish the relationship between parts, sub-systems and/or components, whose failure would impair an essential function of the ship.

The objective of the logic-probabilistic model is to quantify the likelihood, or probability of occurrence, and the consequences of a top event, i.e. the risks against the safety and/or operation of the ship.

The model is developed by means of suitable techniques, such as Fault Tree Analysis (FTA), Event Tree Analysis (ETA), Failure Mode and Effect Analysis (FMEA), Montecarlo simulations, depending on the top events under consideration.

This model is based on the statistical data available, such as the mean time between failures (MTBF) and the mean time to repair (MTTR) of the selected components (see [2.4]).

2.5.2 The fault tree analysis will take into account the duplication required in the Rules for some components (e.g. pumps).

2.6 Analysis of the results

2.6.1 The results from the previous steps are analysed for the identified critical components or systems in order to improve the Inspection and Maintenance Plan, for instance recommending actions concerning:

- preventive maintenance (e.g. inspection intervals)
- corrective maintenance (e.g. procedures for repairs).

2.7 Individuation of the critical components to be monitored

2.7.1 The critical components to be monitored during the ship life are those which result from the risk analysis to have the largest influence on the risks, e.g. the failure of which significantly increases the probability of occurrence of a top event.

2.8 Collection of actual failure and maintenance data

2.8.1 The actual information and data relative to preventive and corrective maintenance and inspection on board are downloaded from the ship database (see Ch 2, Sec 2, [1.3]). In particular, the following data are needed:

- working hours of each component
- mode, cause and time of failure
- down time induced by the failure
- schedule, timing and resources (manpower and consumables) foreseen for the preventive maintenance
- datails on corrective maintenance (spare parts used, tasks carried out, mean time between two corrective actions)
- date when the component has been replaced or re-conditioned.

The actual information and data mentioned above are transformed into statistical parameters, such as the mean time between failure (MTBF) and mean time to repair (MTTB) of each component.

2.9 Updating of failure and maintenance data

2.9.1

a) The actual information and data relative to preventive and corrective maintenance and inspection on board are compared with the ones which were initially assumed to prepare the model. Where necessary, the updated data are introduced in the logic-probabilistic model for a new evaluation of the results and possible re-analysis of the risks.

b) In the case of substantial alterations of the ship machinery and/or equipment, the logic-probabilistic model is modified as far as necessary, using the information available.

c) The modified logic-probabilistic model is used for optimising the maintenance scheme, according to the steps above.

2.10 Analysis of the risk trend

2.10.1 The data relevant to the critical systems and components are gathered during the ship life in order to verify, through the risk analysis, whether a modification of the periodicity of Inspection and Maintenance Plan is necessary.

Appendix 7 Planned Maintenance Scheme

1 General

1.1

1.1.1 A Planned Maintenance Scheme (hereafter referred to as PMS) is a survey system for machinery items which may be considered as an alternative to the Continuous Machinery Survey system (hereafter referred to as CMS), as described in Pt A, Ch 2, Sec 2, [5.4].

This scheme is limited to components and systems covered by CMS.

Any items not covered by the PMS are to be surveyed and credited in the usual way.

1.1.2 This survey scheme is to be approved by the Society before being implemented. When the PMS system is applied, the scope and periodicity of the class renewal survey are tailored for each individual item of machinery and determined on the basis of recommended overhauls stipulated by the manufacturers, documented experience of the operators and, where applicable and fitted, condition monitoring. For instance, within the scope of a PMS system the following cases may occur:

- switchboard A is surveyed based on the regular expiry date of the class renewal survey
- lubricating oil pump B is surveyed based on CMS
- diesel engine C is surveyed based on running hours
- turbo pump D is surveyed based on condition monitoring.

1.1.3 In general, the intervals for the PMS are not to exceed those specified for CMS. However, for components where the maintenance is based on running hours longer intervals may be accepted as long as the intervals are based on the Manufacturer's recommendations.

However, if an approved condition monitoring system is in effect, the machinery survey intervals based on the CMS cycle period may be extended.

1.1.4 When the condition monitoring of machinery and components included in the approved PMS shows that their condition and performance are within the allowable limits, no overhaul is necessary, unless specified by the Manufacturer.

1.1.5 On board the ship there is to be a person responsible for the management of the PMS for the purpose of which he is to possess the appropriate professional qualifications. This person is usually the Chief Engineer; however, another person designated by the Owner may be accepted by the Society provided that his qualifications are considered equivalent to those of the Chief Engineer.

The surveys of machinery items and components covered by the PMS may be carried out by personnel on board who have been issued a statement of authorization, under the conditions and limits given in Pt A, Ch 2, App 1.

Items surveyed by the authorised person will be subject to the confirmatory survey as detailed in Pt A, Ch 2, App 1.

1.1.6 The conditions and procedures for the approval of a PMS are indicated in [2].

2 Conditions and procedures for the approval of the system

2.1 General

2.1.1 The PMS is to be approved by the Society. To this end the Owner is to make a formal request to the Society and provide the documentation and information specified in [2.2], combined in a manual describing the proposed scheme and including sample copies of the different documents to be used during the implementation of the scheme.

2.1.2 The PMS is to be programmed and maintained by a computerised system. However, this may not be applied to the current already approved schemes.

When using computerised systems, access for the purpose of updating the maintenance documentation and the maintenance programmes is only granted to the person responsible for the PMS or another person authorised by him.

Computerised systems are to include back-up devices, such as disks/tapes, CDs, which are to be updated at regular intervals.

The functional application of these systems is to be approved by the Society.

2.2 Documentation

2.2.1 The documentation to be submitted is the manual mentioned above, which is to include:

a) a description of the scheme and its application on board as well as the proposed organisation chart identifying the areas of responsibility and the people responsible for the PMS on board

b) the list of items of machinery and components to be considered for classification in the PMS, distinguishing for each the principle of survey periodicity used as indicated in [1.1.2]

c) the procedure for the identification of the items listed in b), which is to be compatible with the identification system adopted by the Society

d) the scope and time schedule of the maintenance procedures for each item listed in b), including acceptable limit conditions of the parameters to be monitored based on the manufacturers' recommendations or recognised standards and laid down in appropriate preventive maintenance sheets

e) the original reference data, monitored on board, for machinery undergoing maintenance based on condition monitoring

f) the list and specifications of the condition monitoring equipment, including the maintenance and condition monitoring methods to be used, the time intervals for maintenance and monitoring of each item and acceptable limit conditions

g) the document flow and pertinent filing procedure.

2.3 Information on board

2.3.1 The following information is to be available on board:

a) all the documentation listed in [2.2], duly updated

b) the maintenance instructions for each item of machinery, as applicable (supplied by the manufacturer or by the shipyard)

c) the condition monitoring data of the machinery, including all data since the last dismantling and the original reference data

d) reference documentation (trend investigation procedures etc.)

e) the records of maintenance performed, including conditions found, repairs carried out, spare parts fitted

f) the list of personnel on board in charge of the PMS management.

2.4 Annual report

2.4.1 An annual report covering the year's service is to be supplied to the Society. It is to include the following information:

- the list of items of machinery and components (item b) in [2.2.1]) and the procedure for their identification
- the preventive maintenance sheets
- the condition monitoring data, including all data since the last dismantling and the original reference data of the machinery checked through condition monitoring
- any changes to the other documentation in [2.2].
- full trend analysis (including spectrum analysis for vibrations) of machinery displaying operating parameters exceeding acceptable tolerances. In such cases, the actions taken to restore the values of the parameters within the acceptable tolerances are also to be reported.

All the documentation is to be signed by the person responsible mentioned in [1.1.5].

3 Implementation of the system

3.1

3.1.1 When the documentation submitted has been approved and the PMS system has been implemented on board and used for a sufficient period (which is not to exceed one year) so that all personnel become familiar with it, a survey is to be carried out in order to start the system and make it officially operational. The scope of this survey, referred to as Implementation Survey, is given in [5.1.1].

3.1.2 Upon the successful outcome of the Implementation Survey, the PMS is considered approved. The relevant annex to the Certificate of Classification of the ship is updated.

4 Retention and withdrawal of the system

4.1

4.1.1 The PMS system is retained throughout the class period provided that:

- an annual report covering the year's service is supplied to the Society in accordance with [2.4]
- an annual audit in accordance with [5.2] is satisfactorily completed
- any change to the approved PMS is submitted to the Society for agreement and approval.

4.1.2 The survey arrangement for machinery according to the PMS may be withdrawn by the Society if the PMS is not satisfactorily operated on account of either the maintenance records or the general condition of the machinery or the failure to observe the agreed intervals between overhauls.

4.1.3 The Owner may discontinue the PMS at any time by informing the Society in writing. In this case, the items which have been inspected under the PMS since the last annual audit will be credited for class at the discretion of the attending Surveyor.

4.1.4 In the case of sale or change of management of the ship or transfer of class, the approval of the PMS will be reconsidered.

5 Surveys

5.1 Implementation survey

5.1.1 The implementation survey is to be carried out by a Surveyor of the Society, as stated in [3.1.1], within one year from the date of the documentation approval.

5.1.2 The scope of this survey is to verify that:

- the PMS is implemented in accordance with the approved documentation and is suitable for the type and complexity of the components and systems on board
- the documentation required for the annual audit is produced by the PMS
- the requirements of surveys and testing for retention of class are complied with
- the shipboard personnel are familiar with the PMS procedures.

Upon the successful outcome of the survey confirming the proper implementation of the PMS, the system is considered operational subject to the submission to the Society of a report describing the system.

5.2 Annual audit

5.2.1 Once the PMS system is implemented, the continued compliance with the requirements for checks, overhauls and repairs, where needed, indicated in Article [2] is to be verified by means of annual audits in order to confirm the validity of the approved survey scheme system.

5.2.2 The annual audit is to be carried out in conjunction with the annual class surveys.

5.2.3 The purpose of this audit is to verify that the scheme is being correctly operated, in particular that all items (to be surveyed in the relevant period) have actually been surveyed in due time. A general examination of the items concerned is carried out.

5.2.4 The maintenance and performance records are examined to verify that the machinery has been functioning satisfactorily since the previous survey or audit or, if necessary, that the necessary measures have been taken in response to machinery operating parameters exceeding acceptable tolerances, and that the overhaul intervals have been observed.

5.2.5 Written reports of breakdown or malfunction are to be made available.

5.2.6 The description of the repairs, if any, carried out is to be examined. Any machinery part or component which has been replaced by a spare due to damage is to be retained on board, where possible. On this occasion such replaced parts are to be submitted to the examination of the Surveyor.

5.2.7 Where condition monitoring equipment is in use, functions tests, confirmatory inspections and random check readings are to be carried out as far as practicable and reasonable at the discretion of the Surveyor.

5.2.8 The Surveyor also checks that the personnel on board in charge of the PMS have the appropriate authorisation (see Pt A, Ch 2, App 1).

5.2.9 The Surveyor is to review the annual report or verify that it has been reviewed by the Society.

5.2.10 If the Surveyor is not satisfied with the results the PMS is achieving, i.e. with the degree of accuracy as regards the maintenance records and/or the general condition of the machinery, he forwards the Society a report recommending the changes to the survey scheme and explaining the reasons for his suggestions.

5.2.11 Upon the satisfactory outcome of this audit, the Surveyor confirms the validity of the PMS, endorses the Certificate of Classification in accordance with Pt A, Ch 2, Sec 2, [3.3] and decides which items can be credited for class.

5.3 Damage and repairs

5.3.1 Damage to components or items of machinery is to be reported to the Society. The repairs of such damaged components or items of machinery are to be carried out to the satisfaction of the Surveyor.

5.3.2 Any repair and corrective action regarding machinery under the PMS system is to be recorded in the PMS logbook and repair verified by the Surveyor at the Annual Audit.

5.3.3 In the case of outstanding recommendations or records of unrepaired damage which may affect the PMS, the relevant items are to be taken out of the PMS until the recommendations have been fulfilled or the repairs carried out.

6 Machinery items surveyed on the basis of condition monitoring

6.1

6.1.1 The extent of condition-based maintenance and associated monitoring equipment to be included in the maintenance scheme is decided by the Owner. The minimum parameters to be checked in order to monitor the condition of the various machinery for which this type of maintenance is accepted are indicated in [6.1.2] to [6.1.5].

6.1.2 For the main diesel engine the parameters to be checked are the following:

- power output
- rotational speed
- indicator diagram (where possible)
- fuel oil temperature and/or viscosity
- charge air pressure
- exhaust gas temperature for each cylinder
- exhaust gas temperature before and after the turbochargers
- temperatures and pressure of engine cooling systems
- temperatures and pressure of engine lubricating oil system
- rotational speed of turbochargers
- vibrations of turbochargers
- results of lubricating oil analysis
- crankshaft deflection readings
- temperature of main bearings.

6.1.3 For the main and auxiliary steam turbines the parameters to be checked are the following:

- turbine bearing vibrations
- power output
- rotational speed
- plant performance data, i.e. steam conditions at the inlet and outlet of each turbine, saturated, superheated and desuperheated steam conditions at the outlet of boilers, condenser vacuum, sea temperature.

6.1.4 For the auxiliary diesel engines the parameters to be checked are the following:

- exhaust gas temperature before and after the turbochargers
- temperatures and pressure of engine cooling systems
- temperatures and pressure of engine lubricating oil system
- rotational speed of turbochargers
- crankshaft deflection readings.

6.1.5 For other auxiliary machinery the parameters to be checked are the following, as applicable:

- inlet and outlet temperatures of cooling systems
- inlet and outlet temperatures of heating systems
- vibrations and performance data of pumps and fans
- differential pressure at filters.

CHAPTER 3
AVAILABILITY OF MACHINERY (AVM)

Section 1 Alternative Propulsion Mode (AVM-APM)

1 General

1.1 Application

1.1.1 The additional class notation **AVM-APM** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.4.2] to self propelled ships arranged with means for alternative propulsion mode complying with the requirements of this Section. Where several alternative propulsion modes are available, a suffix, according to the number of such modes, is to be added to the notation.

1.2 Principle

1.2.1 The alternative propulsion system is to be capable of maintaining the ship in operating conditions without any restriction of duration. In particular, it should allow the ship to reach the first suitable port or place of refuge, escape from severe environment or other operational hazards. However the limitations specified in [2.1.1] apply.

1.2.2 The alternative propulsion system is to be so designed as to be available in the following cases:

- failure of any component of the main propulsion system or power generation system (see [2.1.3])
- maintenance operations to be carried out on any part of the main propulsion system.

Note 1: Failures of the alternative propulsion system components are not to be considered.

1.3 Definitions

1.3.1 Main propulsion system

Main propulsion system is the machinery installation which allows the ship to reach its full speed capability. It may consist of:

- two or more independent propulsion sets
- two or more propulsion sets having common auxiliaries, or
- one single propulsion set.

1.3.2 Alternative propulsion system

Alternative propulsion system is the machinery installation which allows the ship to reach the performance indicated in [1.2.1] and [2.1.1]. It may be:

- a propulsion set part of the main propulsion system defined in [1.3.1]
- a propulsion system sharing some components with the main propulsion system (e.g. a generator driven by the main propulsion system and used as electric motor, together with its electrical supply system), or
- an independent propulsion set located in the main propulsion compartment or in a separate compartment.

Table 1 : Documents to be submitted

No.	I/A **(1)**	Document
1	I	Machinery spaces general arrangement
2	A	Description of the alternative propulsion system
3	A	A risk analysis demonstrating the availability of the alternative propulsion system in case of a single failure as per [2.1.3] **(2)**
4	A	Calculation note for the fuel capacity necessary to satisfy the range criterion specified in [2.1.1]
5	I	An operating manual with the description of the operations necessary to put the alternative propulsion system into operation when a failure occurs, as listed in [2.1.3]
6	A	Test procedures, including factory acceptance tests and sea trials
7	A	Electrical load balance in APM mode

(1) A : to be submitted for approval
I : to be submitted for information.
(2) This analysis may be in the form of a Failure Mode and Effect Analysis (FMEA), unless the actual arrangement of the machinery and equipment is quite simple and sufficient operating experience can be demonstrated such as to make unlike the possibility of consequence failure in the case of a single failure. In such a case, the Society may consider to accept a functional description of system in lieu of the requested analysis.

1.3.3 Alternative propulsion mode

The alternative propulsion mode (APM) means the operation of the alternative propulsion system alone, without:

- the main propulsion system when both systems are independent
- the rest of the main propulsion system when both systems are combined.

1.4 Documentation to be submitted

1.4.1 The documents listed in Tab 1 are to be submitted.

2 Design requirements

2.1 Availability of the alternative propulsion mode and other ship services

2.1.1 Operating conditions to be achieved when the alternative propulsion mode is activated

Where the alternative propulsion mode is activated, the following operating conditions are to be achieved (calm sea, no current and no wind condition):

- full load speed not less than 7 knots
- operating range of 150 hours, ensured by the provisions detailed in [2.2.1]

2.1.2 Services not required during operation of the alternative propulsion mode

Services not required during APM operation are all non essential services not listed in [2.1.1].

2.1.3 Single failures to be considered

a) The alternative propulsion mode is to be available when any of the following single failures occurs:
   - loss of a main propulsion prime mover
   - any failure of a non-static component of systems which are necessary for the operation of the main propulsion system (i.e. prime movers control and monitoring systems, fuel oil systems, lubricating oil systems, cooling system, compressed air system)
   - any failure of tube heat exchangers, necessary for main propulsion system
   - any failure of any non-static component of fuel oil and lubricating oil transfer system
   - any single failure of any electric apparatus, including total failure of one of the main switchboards, electric motors, transformers, distribution switchboards, panels.

b) The following items do not need to be considered for the purpose of granting the **AVM-APM** notation:
   - rigidly coupled shafting components (i.e. propeller, propeller shaft, intermediate shafts, bearings, couplings, pinions and wheels of reduction gears)
   - static components of the systems which are necessary for the operation of the main propulsion system (i.e. pipes, valves, pipe fittings, pipe supports, tanks, cables)
   - loss of one compartment due to fire or flooding
   - plate type heat exchangers.

c) Consequence failures, i.e. any failure of any component directly caused by a single failure of another component, are also to be considered.

2.2 Machinery systems

2.2.1 Fuel oil tanks

Fuel oil tanks capacity is to take into account all services necessary for APM operation, including the following systems:

- safety systems, including fire fighting systems, bilge system, navigating lights, communication apparatus, life-saving appliances
- minimum habitability services, including minimum lighting (50%), ventilation (50%), air conditioning (= 50%), hospital (100%%), galleys (75%), refrigerated stores (100%), drinking water production (100%)
- ship autodefense system.

An alarm is to be activated when the level in the fuel oil service tank is below the calculated value necessary to achieve the range indicated in [2.1.1]. As an alternative, a dedicated tank of an appropriate capacity is to be made available.

2.2.2 Steering gear

a) In addition to the redundancies (main and auxiliary steering gears or duplication of the power units) required by SOLAS Regulation II-1/29 and 30), the steering gear is to be so designed as to remain available in case of single failure affecting any other active component, such as a rudder actuator.

b) Performance of the steering gear in case of single failure is to be in compliance with the criteria stated in Resolution MSC.137(76) "Standards for ship manoeuvrability" and in IMO Circular MSC/Circ.1053 "Explanatory notes to the standards for ship manoeuvrability".

2.2.3 Activation of the alternative propulsion mode

When the alternative propulsion system shares some components with the main propulsion system, it is to be capable of being activated with an effective, readily usable system, in a time not exceeding half an hour.

2.3 Electrical systems

2.3.1 Main switchboard

In case of loss of one main switchboard, the alternative propulsion system is to remain available.

2.3.2 Emergency generator

The emergency generator is not to be considered in the electrical load balance when the alternative propulsion mode is active.

3 Tests on board

3.1 Factory acceptance tests

3.1.1 The components of the alternative propulsion system are to be subjected to the running tests required by the Rules.

3.1.2 Where the alternative electrical propulsion system is provided, the integration tests of the alternative propulsion system are to be carried out in factory prior to installation.

3.2 Sea trials

3.2.1 Alternative propulsion system

The alternative propulsion system is to undergo the following tests during the sea trials:

- activation test (see [2.2.3])
- test to demonstrate the performance required in [2.1.1]
- test required by the risk analysis conclusions and, where deemed necessary, simulation of certain single failures.

Note 1: During the test, the power and rotational speed of the alternative propulsion system and the ship speed are to be recorded.

3.2.2 Steering gear

The performance test of the steering gear is to be carried out assuming a single failure, in accordance with the provisions of [2.3.2].

Section 2 Duplicated Propulsion System (AVM-DPS)

1 General

1.1 Application

1.1.1 The additional class notation **AVM-DPS** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.4.3] to self propelled ships arranged with duplicated propulsion and steering systems complying with the requirements of this Section.

1.2 Principle

1.2.1 General

Ships having the notation **AVM-DPS** are to be fitted with at least:

- two independent propulsion sets, so arranged that at least 50% of the overall power remains available whenever any of the propulsion plant is not in operation
- two steering sets, so arranged that the full steering capability of the ship is maintained in case of failure of one steering set.

Note 1: The propulsion sets may be installed in the same compartment.

Note 2: The steering gears may be installed in the same compartment.

1.2.2 Propulsion

Each propulsion set is to be so designed as to individually comply with the relevant provisions of Part C, Chapter 1 and Part C, Chapter 2. In particular, its operation is to be maintained or restored even in case of single failure of one component, as listed in [2.2.1]. Partial reduction of the propulsion set capability may however be accepted when it is demonstrated that the safe operation of the ship is not impaired.

1.2.3 Steering

Each steering set is to be so designed as to individually comply with the provisions of Pt C, Ch 1, Sec 12.

1.3 Definitions

1.3.1 Propulsion set

A propulsion set includes the following components:

- propeller (or impeller)
- shafting
- gear box (where provided)
- driven generators and pumps (where provided)
- flexible coupling (where provided)
- prime mover
- fuel supply, lubrication, cooling, starting and control systems.

1.3.2 Independent propulsion sets

Propulsion sets are said to be independent where no common auxiliary systems are provided. It means that each propulsion set has dedicated fuel supply, lubrication, cooling, starting and control systems.

1.3.3 Steering set

A steering set includes the rudder, the rudder stock and the steering gear.

1.4 Documentation to be submitted

1.4.1 The documents listed in Tab 1 are to be submitted.

Table 1 : Documents to be submitted

No.	I/A **(1)**	Document
1	I	Machinery spaces general arrangement
2	A	Description of the propulsion installation
3	A	Description of the steering installation
4	A	A risk analysis demonstrating the availability of the operating conditions as per [2.1.1] in case of a single failure as per [2.2.1] **(2)**
5	I	An operating manual with the description of the operations necessary to recover: • the propulsion in case of failure of one propulsion set • the operation of a propulsion set when affected by a single failure (see [2.2.1]) • the steering in case of failure of one steering set.

(1) A : to be submitted for approval ; I : to be submitted for information.
(2) This analysis may be in the form of a Failure Mode and Effect Analysis (FMEA). Ch 3, App 1 describes an acceptable procedure for carrying out the FMEA.

2 Design requirements

2.1 Performance of the propulsion plant with one propulsion set inoperative

2.1.1 Operating conditions to be achieved with one propulsion set inoperative

The performance required in [1.2.1] for the propulsion plant with one propulsion set inoperative is to satisfy the following criteria:

- full load speed not less than 7 knots
- no restriction of the operating range
- availability of safety systems, including fire fighting systems, bilge system, navigating lights, communication apparatus, life-saving appliances
- minimum habitability conditions, including minimum lighting, ventilation, air conditioning, galleys, refrigerated stores, drinking water or evaporator services (see Ch 3, Sec 1)
- operational efficiency (including combat system and stabilizers).

2.1.2 Services not required during the operation of the propulsion plant with one propulsion set inoperative

The non-essential services not listed in [2.1.1] need not be supplied during the operation of the propulsion plant with one propulsion set inoperative.

2.2 Single failures to be considered for the propulsion set design

2.2.1 The propulsion sets are to be so designed as to remain available when one of the following failures occurs:

- an electrically driven pump for fuel supply, cooling and lubrication
- an air compressor for starting or control purposes
- a tube heat exchanger
- a fan serving the concerned machinery compartment.

2.3 Design of machinery systems

2.3.1 Fuel oil system

At least two store tanks and two service tanks are to be fitted, with means to periodically equalize the content on each set of tanks during the consumption of the fuel.

An alarm is to be activated when the level in any fuel oil storage tank is below the calculated value necessary to achieve a 150 hours range.

2.3.2 Ventilation system

Where the propulsion sets are located in a common compartment, the ventilation system serving this compartment is to be so designed as to allow the operation of the propulsion sets with an aggregate capacity of at least 50% of the full capacity while satisfying the temperature criteria laid down in Pt C, Ch 1, Sec 1, [2.5.2].

2.3.3 Steering systems

Where ships do not have traditional rudder and steering gears, being their steering capability supplied by azimuth thrusters or equivalent features, means are to be provided to allow at least the same redundancy as that afforded by two independent steering systems.

2.3.4 Recovery of the propulsion and steering in case of failures

The time for recovering:

- the propulsion in case of failure of one propulsion set
- the operation of a propulsion set when affected by a single failure (see [2.2.1])
- the steering in case of failure on one steering set

is not to exceed half an hour.

2.4 Design of electrical installations

2.4.1 At least two main sources of electrical power and two main switchboards are to be provided.

2.5 Design of automation systems

2.5.1 The automation system is to be arranged in such a way as to prevent the possibility that a single failure of the control system may lead to the loss of more than one propulsion system.

3 Tests on board

3.1 Running tests

3.1.1 The duplicated propulsion system is to be subjected to the running tests required by the Rules for similar systems.

3.2 Sea trials

3.2.1 Operation of the ship with one propulsion set inoperative

The sea trials are to include the following tests with one propulsion set inoperative:

- propulsion recovery test (see [2.3.4])
- speed measurement test.

Note 1: During the test, the power and the rotational speed of the active propulsion set are also to be recorded.

3.2.2 Operation of a propulsion set in case of single failure

During the sea trials, each type of propulsion set is to be subjected to the following tests:

- propulsion recovery test (see [2.3.4])
- tests required by the risk analysis conclusions and, where deemed necessary, simulation of certain single failures.

3.2.3 Steering system

The sea trials are to include a a recovery test of the steering system with one steering set inoperative.

Section 3 Independent Propulsion System (AVM-IPSx-(V))

1 General

1.1 Application

1.1.1 The additional class notation **AVM-IPSx-(V)** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.4.4] to self propelled ships arranged with means for independent propulsion system complying with the requirements of this Section.

1.1.2 This notation is granted, provided that:

a) The ship is arranged with at least two propellers and the associated independent shafting, each one independently driven by separate machinery, in such a way that at least 50% of the power remains available whenever any of the propulsion machinery and the associated propeller and shafting are out of service.

   It is also applicable to ships arranged with at least two independent azimuth thrusters and any other equivalent arrangement.

b) The propulsive installations are arranged in different compartments, in such a way that at least 50% of the power installed on board is still available whenever the machinery arranged in any one compartment is not operating

c) The arrangement of the independent propulsion system is such as to allow the ship to reach the first suitable port or place of refuge, or to escape from severe environment, providing the minimum services for navigation, preservation of cargo and habitability in case of any single failure.

1.2 Coverage of AVM-IPSx-(V) notation

1.2.1 Applicability

The following operating conditions are to be achieved:

- In case one propulsion system becomes inoperative due to a system failure coming from any single failure of one of the items specified in Ch 3, Sec 1, [2.1.3], at least 50% of the propulsion systems of the ship remains available and allows the ship to proceed at a speed of not less than 7 knots assuming that:
  - the ship is fully laden
  - the wind speed is equal to 11 m/s
  - the significant wave height is 2,4 m with a mean period equal to 6,5 s.
- In case of a fire or a flooding casualty, sufficient propulsion power is to remain available to allow the ship to proceed at speed of not less than 7 knots assuming that:
  - the ship is fully laden
  - the wind speed is equal to 11 m/s
  - the significant wave height is 2,4 m with a mean period equal to 6,5 s.
- Full load speed not less than **V** knots, where V is a speed specified by the owner, but not less than 7 knots
- Range of 1000 nautical miles or range corresponding to 1/2 of the range achievable with the full supply of fuel, whichever is the less
- Duplicated steering rudder and steering gear, or equivalent arrangement to ensure full steering capability in case of a major failure of the rudder or steering gear
- Availability of safety systems, including fire fighting systems, bilge system, navigating lights, communication apparatus, life-saving appliances
- Habitability conditions, including minimum lighting, ventilation, galleys, refrigerated stores, drinking water or evaporator services
- Operational efficiency (including combat system and stabilizers).

1.2.2 Services not available during emergency operation of the independent propulsion system

The following services need not to be supplied during the emergency operation of one (or more) of the propulsion systems, when any of the propulsion system is not available due to a single failure of any component of the propulsion plant or of any of the auxiliaries and equipment necessary for the propulsion:

Non essential services.

1.2.3 Use of the independent propulsion system in case of single failure

In order to grant **AVM-IPSx-(V)**, the independent propulsion system is to be arranged in such a way that the ship can continue or can recover in such a short time, as not to impair the safety of the ship, its operation in the case of a single failure (as defined in Ch 3, Sec 1, [2.1.3]) of any component of the main propulsion, steering or power generation system.

1.2.4 Single failure concept

a) A single failure of static and non-static components of the propulsion, steering and power generation systems is to be considered. Consequence failures, i.e. any failure of any component directly caused by a single failure of another component, are also to be considered.

b) The loss of one or more compartment due to fire or flooding. The possible notations in this respect are:

- **AVM-IPS1-(V)** notation is granted to ships having the propulsion systems and power generating stations arranged in compartments which are contiguous each other, and therefore the damage in way of a bulkhead, and the consequent loss of two adjacent compartments due to flooding does not allow the ship to comply with the condition in [1.2.1]
- **AVM-IPS2-(V)** notation is granted to ships having the propulsion and auxiliary systems arranged in non contiguous compartments and arranged so that a damage in way of a bulkhead, and the consequent loss of two adjacent compartments due to flooding still allows the ship to comply with the condition in [1.2.1]; irrespective of what above, the steering gear arrangements need not to be installed in non-contiguous spaces, provided that the functionality of the steering gears is granted also under flooded condition by means of either the selection of adequate components (e.g. having a suitable degree of protection) or of their position with respect to the waterline in flooded conditions.

1.2.5 Redundancy

All the redundancies normally required by the Rules are to be foreseen also under a single failure case of independent propulsion, with the exception of its control system.

1.3 Documentation to be submitted

1.3.1 The documents listed in Tab 1 are to be submitted.

Table 1 : Documents to be submitted

No.	I/A **(1)**	Document
1	I	Machinery spaces general arrangement
2	A	Description of the independent propulsion system
3	A	An analysis demonstrating the availability of the operating conditions as per Ch 3, Sec 1, [2.1.1] in case of a single failure as per Ch 3, Sec 1, [2.1.3] **(2)**
4	I	An operating manual with the description of the operations necessary to recover the propulsion and essential services in case of a single failure as described in Ch 3, Sec 1, [2.1.3]

(1) A : to be submitted for approval ; I : to be submitted for information.
(2) This analysis may be in the form of a Failure Mode and Effect Analysis (FMEA). Ch 3, App 1 describes an acceptable procedure for carrying out the FMEA.

2 Special arrangements

2.1 Systems for cooling, lubrication, fuel supply, air starting, monitoring and control

2.1.1 General

The systems are to be constructed such as to satisfy the conditions stipulated in Ch 3, Sec 1, [2.1]. In addition to what stated in the relevant parts of the Rules, the following requirements apply.

2.1.2 Pumps

For the assignment of the **AVM-IPSx-(V)** notation, the systems concerned are to be provided with at least two pumps, one as a stand-by of the other. One of the two pumps may be driven by the propulsion machinery, while the other pump is to be independently driven.

2.1.3 Cooling system

Separate cooling systems are to be provided for each compartment of the main propulsion system. In general, separate cooling systems are to be provided for each main propulsion system, unless the FMEA demonstrates that one cooling system serving all propulsion systems within one compartment is arranged in such a way that any single failure of the system does not make inoperative all the propulsion systems of the compartment.

2.1.4 Lubricating oil system

Each main propulsion system is to be fitted with a separate lubrication oil system.

2.1.5 Fuel oil system

At least two store tanks and two service tanks are to be fitted. Means are to be provided to periodically equalize the content on each set of tanks during the consumption of the fuel, in order to achieve the minimum range indicated in [1.2.1] after a single failure.

2.1.6 By-pass

Means are to be provided to by-pass and shut-off each of the components which may be subject of a single failure, as defined in Ch 3, Sec 1, [2.1.3], without impairing the functioning of the system itself (including machinery and equipment) or of the other systems which are to be operated in connection with navigation in emergency.

2.1.7 Piping segregation

Piping systems connecting the independent propulsion systems located in different spaces or piping systems serving one propulsion systems and passing through the spaces where another independent propulsion system is arranged are to be fitted with closing devices on both sides of the separating bulkheads, which are to be kept permanently closed.

2.2 Rudders and steering gears

2.2.1

a) Duplicated rudders and steering gears are to be arranged in separate compartments.

b) Where ships do not have traditional rudder and steering gears, being their steering capability supplied by azimuth thrusters or equivalent features, means are to be provided to allow at least the same redundancy as required in a) above.

2.3 Electrical installations

2.3.1

a) Where the propulsion systems are supplied by the main source of electrical power, the capacity of the electric generators is to be that indicated in Pt C, Ch 2, Sec 3, [2.2], with the exception of those services indicated in [1.2.4], including the power requested for the duplicated propulsion, without recourse to the emergency source of electrical power and with any one of the generating sets spaces unavailable.

b) At least two main sources of electrical power and two main switchboards are to be provided.

c) The power supplies to a machinery space are not to pass through the spaces where other independent propulsion systems are arranged, unless a second power supply to the same apparatus is fitted and not passing through the same spaces.

2.4 Automation

2.4.1 The automation system is to be arranged in such a way as to prevent the possibility that a single failure of the control system may lead to the loss of more than one propulsion system.

3 Tests on board

3.1 Running tests

3.1.1 The independent propulsion system is to be subjected to the running tests required by the Rules for similar systems.

3.2 Sea trials

3.2.1 In the course of sea trials the single failures mentioned in Ch 3, Sec 1, [2.1.3] are to be simulated and the values of the power and speed developed in this condition are to be recorded.

Appendix 1 Procedures for Failure Modes and Effect Analysis

1 General

1.1 Introduction

1.1.1 FMEA requirement

As specified in Ch 3, Sec 1, Ch 3, Sec 2 and Ch 3, Sec 3 in order to grant the **AVM** notations, an FMEA is to be carried out, with the exception indicated in Note 2 of Ch 3, Sec 1, Tab 1 to demonstrate that, in case of single failure to the propulsion, steering or power generating system, the ship is still capable to achieve the performances indicated in the applicable Sections as a condition for granting the notation.

1.1.2 Scope of the Appendix

This Appendix describes a failure mode and effects analysis (FMEA) and gives guidance as to how it may be applied by:

a) explaining basic principles

b) providing the procedural steps necessary to perform an analysis

c) identifying appropriate terms, assumptions, measures and failure modes, and

d) providing examples of the necessary worksheets.

1.1.3 Definition of FMEA

A practical, realistic and documented assessment of the failure characteristics of the ship and its component systems aiming at defining and studying the important failure conditions that may exist.

1.1.4 FMEA principles

The FMEA is based on a single failure concept under which each considered system at various levels of a system's functional hierarchy is assumed to fail by one probable cause at a time. The effects of the postulated failure are analysed and classified according to their severity. Such effects may include secondary failures (or multiple failures) at other level(s). Any failure mode which may cause a catastrophic effect should be safeguarded by either system or equipment redundancy unless the probability of such failure is extremely improbable. For failure modes causing hazardous effects corrective measures may be accepted in lieu.

1.1.5 Alternatives

While FMEA is suggested as one of the most flexible analysis techniques, it is accepted that there are other methods which may be used and which in certain circumstances may offer an equally comprehensive insight into particular failure characteristics. These methods may be accepted by the Society on case by case base.

1.2 Objectives

1.2.1 Primary objective

The primary objective of FMEA is to provide a comprehensive, systematic and documented investigation which establishes the important failure conditions of the ship propulsion, steering and power generation systems and assesses their significance with regard to the safety of the ship and her occupants.

1.2.2 Aim of the analysis

The main aims of undertaking the analysis are to:

a) provide ship and system designers with data to audit their proposed designs

b) provide the Owner with the results of a study into ship's selected systems failure characteristics so as to assist in an assessment of the measures to be taken to limit the damages consequent of the failure within acceptable limits

c) provide the Master and crew of the ship with data to generate comprehensive training, operational and maintenance programmes and documentation.

1.3 Sister ships

1.3.1 For ships of the same design and having the same equipment, one FMEA on any one of such ships may be sufficient.

1.4 FMEA basics

1.4.1 Before proceeding with a detailed FMEA into the effects of the failure of the system elements on the system functional output it is necessary to perform a functional failure analysis of the considered systems. In this way only systems which fail the functional failure analysis need to be investigated by a more detailed FMEA.

1.4.2 Operational modes

When conducting a system FMEA the following typical operational modes within the normal design environmental conditions of the ships are to be considered:

a) normal seagoing conditions at full speed

b) maximum permitted operating speed in congested waters

c) manoeuvring alongside

d) seagoing conditions in emergency, as defined in Ch 3, Sec 1, Ch 3, Sec 2 and Ch 3, Sec 3.

1.4.3 Functional interdependence

This functional interdependence of these systems is also to be described in either block diagrams or fault tree diagrams or in a narrative format to enable the failure effects to be understood. As far as applicable, each of the systems to be analysed is assumed to fail in the following failure modes:

a) complete loss of function

b) rapid change to maximum or minimum output

c) uncontrolled or varying output

d) premature operation

e) failure to operate at a prescribed time

f) failure to cease operation at a prescribed time.

Depending on the system under consideration other failure modes may have to be taken into account.

1.4.4 Systems which can fail without catastrophic effects

If a system can fail without any hazardous or catastrophic effect, there is no need to conduct a detailed FMEA into the system architecture. For systems whose individual failure can cause hazardous or catastrophic effects and where a redundant system is not provided, a detailed FMEA as described in the following paragraphs should be followed.

1.4.5 Redundant systems

Where a system, the failure of which may cause a hazardous or catastrophic effect, is provided with a redundant system, a detailed FMEA may not be required provided that:

a) The redundant system can be put into operation or can take over the failed system within the time-limit dictated by the most onerous operational mode without hazarding the ship

b) The redundant system is completely independent from the system and does not share any common system element the failure of which would cause failure of both the system and the redundant system. Common system element may be acceptable if the probability of failure complies with [4]

c) If the redundant system uses the same power source as the system, an alternative power source is readily available with regard to the requirement of a) above.

The probability and effects of operator’s error to bring in the redundant system are also to be considered.

1.5 FMEA analysis

1.5.1 The systems to be subject to a more detailed FMEA investigation at this stage are to include all those that have failed the system FMEA and may include those that have a very important influence on the safety of the ship and her occupants and which require an investigation at a deeper level than that undertaken in the system functional failure analysis. These systems are often those which have been specifically designed or adapted for the ship, such as the craft’s electrical and hydraulic systems.

2 FMEA performance

2.1 Procedures

2.1.1 The following steps are necessary to perform an FMEA:

a) to define the system to be analysed

b) to illustrate the interrelationships of functional elements of the system, by means of block diagrams

c) to identify all potential failure modes and their causes

d) to evaluate the effects on the system of each failure mode

e) to identify failure detection methods

f) to identify corrective measures for failure modes

g) to assess the probability of failures causing hazardous or catastrophic effects, where applicable

h) to document the analysis

i) to prepare FMEA report.

2.2 System definition

2.2.1 The first step in an FMEA study is a detailed study of the system to be analysed, through the use of drawings and equipment manuals. A narrative description of the system and its functional requirements is to be drawn up including the following information:

a) general description of system operation and structure

b) functional relationship among the system elements

c) acceptable functional performance limits of the system and its constituent elements in each of the typical operational modes

d) system constraints.

2.3 Development of system block diagram

2.3.1 Block diagram

The next step is to develop block diagram(s) showing the functional flow sequence of the system, both for technical understanding of the functions and operation of the system, and for the subsequent analysis. As a minimum the block diagram is to contain:

a) breakdown of the system into major sub-systems or equipment

b) all appropriate labelled inputs and outputs and identification numbers by which each sub-system is consistently referenced

c) all redundancies, alternative signal paths and other engineering features which provide “fail-safe” measures.

2.3.2 Block diagrams and operational modes

It may be necessary to have a different set of block diagrams prepared for each different operational modes.

2.4 Identification of failure modes, causes and effects

2.4.1 Failure mode

Failure mode is the manner by which a failure is observed. It generally describes the way the failure occurs and its impact on the equipment or system. As an example, a list of failure modes is given in Tab 1. The failure modes listed in Tab 1 can describe the failure of any system element in sufficiently specific terms. When used in conjunction with performance specifications governing the inputs and outputs on the system block diagram, all potential failure modes can be thus identified and described. Thus, for example, a power supply may have a failure mode described as “loss of output” (29), and a failure cause “open (electrical)” (31).

2.4.2 System failure

A failure mode in a system element could also be the failure cause of a system failure. For example, the hydraulic line of a steering gear system might have a failure mode of “external leakage” (10). This failure mode of the hydraulic line could become a failure cause of the steering gear system’s failure mode “loss of output” (29).

2.4.3 Top-down approach

Each system should be considered in a top-down approach, starting from the system’s functional output, and failure is to be assumed by one possible cause at a time. Since a failure mode may have more than one cause, all potential independent causes for each failure mode are to be identified.

2.4.4 Delay effect when operating back-up systems

If major systems can fail without any adverse effect there is no need to consider them further unless the failure can go undetected by an operator. To decide that there is no adverse effect does not mean just the identification of system redundancy. The redundancy is to be shown to be immediately effective or brought on line with negligible time lag. In addition, if the sequence is: “failure - alarm - operator action - start of back up- back up in service”, the effects of delay should be considered.

Table 1 : Example of failure mode list

1	Structural failure (rupture)
2	Physical binding or jamming
3	Vibration
4	Fails to remain in position
5	Fails to open
6	Fails to close
7	Fails open
8	Fails closed
9	Internal leakage
10	External leakage
11	Fails out of tolerance (high)
12	Fails out of tolerance (low)
13	Inadvertent operation
14	Intermittent operation
15	Erratic operation
16	Erroneous indication
17	Restricted flow
18	False actuation
19	Fails to stop
20	Fails to start
21	Fails to switch
22	Premature operation
23	Delayed operation
24	Erroneous input (increased)
25	Erroneous input (decreased)
26	Erroneous output (increased)
27	Erroneous output (decrease)
28	Loss of input
29	Loss of output
30	Shorted (electrical)
31	Open (electrical)
32	Leakage (electrical)
33	Other unique failure conditions as applicable to the system characteristics, requirements and operational constraints

2.5 Failure effects

2.5.1 Concept

The consequence of a failure mode on the operation, function, or status of an equipment or a system is called a “failure effect”. Failure effects on a specific sub-system or equipment under consideration are called “local failure effects”. The evaluation of local failure effects will help to determine the effectiveness of any redundant equipment or corrective action at that system level. In certain instances, there may not be a local effect beyond the failure mode itself.

2.5.2 End effect

The impact of an equipment or sub-system failure on the system output (system function) is called an “end effect”. End effects should be evaluated and their severity classified in accordance with the following categories:

a) catastrophic

b) hazardous

c) major

d) minor.

The definition of these four categories of failure effects is in Article [4].

2.5.3 Catastrophic and hazardous effects

If the end effect of a failure is classified as hazardous or catastrophic, back-up equipment is usually required to prevent or minimize such effect. For hazardous failure effects corrective operational procedures may be generally accepted.

2.6 Failure detection

2.6.1 Detectable failures

The FMEA study in general only analyses failure effects based on a single failure in the system and therefore a failure detection means, such as visual or audible warning devices, automatic sensing devices, sensing instrumentation or other unique indications, is to be identified.

2.6.2 Non detectable failures

Where the system element failure is non-detectable (i.e. a hidden fault or any failure which does not give any visual or audible indication to the operator) and the system can continue with its specific operation, the analysis is to be extended to determine the effects of a second failure, which in combination with the first undetectable failure may result in a more severe failure effect e.g. hazardous or catastrophic effect.

2.7 Corrective measures

2.7.1 Back-up equipment response

The response of any back-up equipment, or any corrective action initiated at a given system level to prevent or reduce the effect of the failure mode of system element or equipment, is also to be identified and evaluated.

2.7.2 Corrective design provisions

Provisions which are features of the design at any system level to nullify the effects of a malfunction or failure, such as controlling or deactivating system elements to halt generation or propagation of failure effects, activating back-up or standby items or systems, are to be described. Corrective design provisions include:

a) redundancies that allow continued and safe operation

b) safety devices, monitoring or alarm provisions, which permit restricted operation or limit damage

c) alternative modes of operation.

2.7.3 Manual corrective actions

Provisions which require operator action to circumvent or mitigate the effects of the postulated failure are to be described. The possibility and effect of operator’s errors is to be considered, if the corrective action or the initiation of the redundancy requires operator input, when evaluating the means to eliminate the local failure effects.

2.7.4 Acceptability of corrective action

It is to be noted that corrective responses acceptable in one operational mode may not be acceptable at another, e.g. a redundant system element with considerable time lag to be brought into line, while meeting the operational mode “normal seagoing conditions at full speed” may result in a catastrophic effect in another operational mode, e.g. “maximum permitted operating speed in congested water”.

2.8 Use of probability concept

2.8.1 Acceptance criteria

If corrective measures or redundancy as described in previous paragraphs are not provided for any failure, as an alternative the probability of occurrence of such failure is to meet the following criteria of acceptance:

a) a failure mode which results in a catastrophic effect is to be assessed to be extremely improbable

b) a failure mode assessed as extremely remote is to not result in worse than hazardous effects

c) a failure mode assessed as either frequent or reasonably probable is not to result in worse than minor effects.

2.8.2 Data

Numerical values for various levels of probabilities are laid down in [4]. In areas where there is no data from ships to determine the level of probabilities of failure other sources can be used such as:

a) workshop test

b) history of reliability used in other areas under similar operating conditions

c) mathematical model if applicable.

2.9 Documentation

2.9.1 Worksheet

It is helpful to perform FMEA on worksheets. Tab 2 shows an example of worksheet.

2.9.2 Worksheet organization

The worksheets are be organized to first display the highest system level and then proceed down through decreasing system levels.

Table 2 : FMEA worksheet

Name of system: Mode of operation: Sheet No: Date: Name of analyst:							References: System block diagram: Drawings:				
Equipment name or number	Function	Ident. No.	Failure mode	Failure cause	Failure effect		Failure detection	Corrective action	Severity of failure effect	Probability of failure (if applicable)	Remarks
					Local effect	End effect					

3 Tests and reporting

3.1 Reporting

3.1.1 The FMEA report is to be a self-contained document with a full description of the craft, its systems and their functions and the proposed operation and environmental conditions for the failure modes, causes and effects to be understood without any need to refer to other plans and documents not in the report. The analysis assumptions and system block diagrams are to be included, where appropriate.

The report is to contain a summary of conclusions and recommendations for each of the systems analysed in the system failure analysis and the equipment failure analysis. It is also to list all probable failures and their probability of failure where applicable, the corrective actions or operational restrictions for each system in each of the operational modes under analysis.

4 Probabilistic concept

4.1 General

4.1.1 For the purposes of this Chapter, the following definitions apply.

4.2 Occurrences

4.2.1 Occurrence

Occurrence is a condition involving a potential lowering of the level of safety.

4.2.2 Failure

Failure is an occurrence in which a part, or parts, of the ship fail. A failure includes:

a) a single failure

b) independent failures in combinations within a system, and

c) independent failures in combinations involving more than one system, taking into account:

    1) any undetected failure that is already present

    2) such further failures as would be reasonably expected to follow the failure under consideration, and

d) common cause failure (failure of more than one component or system due to the same cause).

Note 1: In assessing the further failures which follow, account should be taken of any resulting more severe operating conditions for items that have not up to that time failed.

4.2.3 Event

Event is an occurrence which has its origin outside the craft (e.g., waves).

4.2.4 Error

Error is an occurrence arising as a result of incorrect action by the operating crew or maintenance personnel.

4.3 Probability of occurrences

4.3.1 Frequent

Frequent is an occurrence which is likely to happen often during the operational life of a particular ship.

4.3.2 Reasonably probable

Reasonably probable is an occurrence which is unlikely to happen often but which may happen several times during the total operational life of a particular ship.

4.3.3 Recurrent

Recurrent is a term embracing the total range of frequent and reasonably probable.

4.3.4 Remote

Remote is an occurrence which is unlikely to happen to every ship but may happen to a few ships of a type over the total operational life of a fleet of ship of the same type.

4.3.5 Extremely remote

Extremely remote is an occurrence which is unlikely to happen when considering the total operational life of a fleet of ships of the same type, but nevertheless is considered as being possible.

4.3.6 Extremely improbable

Extremely improbable is an occurrence which is so unlikely to happen extremely remote that it is considered as not being possible to happer.

4.4 Effects

4.4.1 Effect

Effect is a situation arising as a result of an occurrence.

4.4.2 Minor effect

Minor effect is an effect which may arise from a failure, an event, or an error which can be readily compensated for by the operating crew; it may involve:

a) a small increase in the operational duties of the crew or in their difficulty in performing their duties, or

b) a moderate degradation in handling characteristics, or

c) slight modification of the normal operating conditions.

4.4.3 Major effect

Major effect is an effect which produces:

a) a significant increase in the operational duties of the crew or in their difficulty in performing their duties which by itself should not be outside the capability of a competent crew provided that another major effect does not occur at the same time, or

b) significant degradation in handling characteristics, or

c) significant modification of the normal operating conditions, but will not remove the capability to complete a safe journey without demanding more than normal skill on the part of the operating crew.

4.4.4 Hazardous effect

Hazardous effect is an effect which produces:

a) a dangerous increase in the operational duties of the crew or in their difficulty in performing their duties of such magnitude that they cannot reasonably be expected to cope with them and will probably require outside assistance, or

b) dangerous degradation of handling characteristics, or

c) dangerous degradation of the strength of the ship, or

d) marginal conditions for, or injury to, occupants, or

e) an essential need for outside rescue operations.

4.4.5 Catastrophic effect

Catastrophic effect is an effect which results in the loss of the craft and/or in fatalities.

4.5 Safety level

4.5.1 Safety level is a numerical value characterizing the ship performance. The safety levels and the corresponding severity of effects on crew and safety criteria for ship performance are defined in Tab 3.

Table 3 : Severity levels on crew

Effect	Criteria not to be exceeded Type of load	Value **(2)**	Comment
Level 1 Minor Effect Moderate degradation of safety	Maximum acceleration measured horizontally **(1)**		0,08g and 0,20g/s **(3)**: Elderly person will keep balance when holding 0,15g and 0, g/s: Mean person will keep balance when holding 0,15g and 0,80g/s: Sitting person will start holding
Level 2 Major Effect Significant degradation of safety	Maximum acceleration measured horizontally **(1)**		0,25g and 2g/s: Maximum load for mean person keeping balance when holding 0,45g and 10g/s: Mean person fails out of seat when nor wearing seat belts
Level 3 Hazardous Effect Major degradation of safety	Collision design condition calculated Maximum structural design load, based on vertical acceleration at centre of gravity		Risk of injury to persons, safe emergency operation after collision 1g: Degradation of person safety
Level 4 Catastrophic Effect			Loss of ship and/or fatalities

(1) The recording instruments used are to be such that the acceleration accuracy is better than 5% of the real value and frequency response is to be minimum 20 Hz. Antialiasing filters with maximum passband attenuation 100 + 5% are to be used
(2) g = gravity acceleration (9,81 m/s_2)
(3) g-rate of jerk may be evaluated from acceleration/time curves.

4.6 Numerical values

4.6.1 Where numerical probabilities are used in assessing compliance with requirements using the terms similar to those given above, the approximate values given in Tab 4 may be used as guidance (values are on an hourly basis). The probabilities quoted in the analysis should be on an hourly or per journey basis, depending on which is more appropriate to the assessment in question.

Note 1: Different occurrences may have different acceptable probabilities, according to the severity of their consequences (see Tab 5).

Table 4 : Guidance for probability levels

Frequent	More than 10^{-3}
Reasonably probable	10^{-3} to 10^{-5}
Remote	10^{-5} to 10^{-7}
Extremely remote	10^{-7} to 10^{-9}
Extremely improbable	Whilst no approximate numerical probability is given for this, the figures used should be substantially less than 10^{-9}

Table 5 : Examples of acceptable levels

SAFETY LEVEL	1	1	1	2	3	4
EFFECT ON SHIP AND OCCUPANTS	Normal	Nuisance	Operating limitations	Emergency procedures; significant reduction in safety margins; difficult for crew to cope with adverse conditions; person injuries	Large reduction in safety margin; crew over-burden because of work-load or environmental conditions; serious injuries to small number of persons	Casualties and deaths, usually with loss of ship
F.A.R. PROBABILITY**(1)**	Probable			Improbable		Extremely improbable
JAR-25 PROBABILTY**(2)**	Probable			Improbable		Extremely improbable
	Frequent		Reasonably probable	Remote	Extremely remote	
	10^{-0}	10^{-2}	10^{-3}	10^{-5}	10^{-7}	10^{-9}
CATEGORY OF EFFECT	Minor			Major	Hazardous	Catastrophic

(1) The United States Federal Aviation Regulation
(2) European Joint Airworthiness Regulations

Part E
Additional Class Notations

CHAPTER 4
AUTOMATION SYSTEMS (AUT)

Section 1 Qualified Automation Systems (AUT-QAS)

1 General

1.1 Application

1.1.1 The additional class notation **AUT-QAS** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.5.2] to ships fitted with automated installations enabling periodically unattended operation of machinery spaces, and complying with the requirements of this Section.

Note 1: Machinery spaces are defined in Pt C, Ch 1, Sec 1.

1.1.2 The arrangements provided are to be such as to ensure that the safety of the ship in all sailing conditions, including manoeuvring, is equivalent to that of a ship having the machinery spaces manned.

1.2 Communication system

1.2.1 A reliable means of vocal communication is to be provided among all machinery spaces, their machinery control room, the continuously manned central operating position(s) and the navigation bridge.

1.2.2 Navigation bridge, continuously manned control position and propulsion and steering control positions are to be served by a reliable communication network able to permit simultaneous communication.

1.2.3 The location and the design of the means of communication referred to in [1.2.2] are to be such that the manual operation of the propulsion and steering machinery may be assured also in case of failure of the remote control system.

1.2.4 Means of communication are to be capable of being operated even in the event of failure of supply from the main source of electrical power.

1.2.5 The capacity of the battery assuring the continuity of the supply is to be of at least 30 min.

2 Documentation

2.1 Documents to be submitted

2.1.1 In addition to those mentioned in Pt C, Ch 3, Sec 1, Tab 1, the documents in Tab 1 are required.

Table 1 : Documents to be submitted

No.	I/A**(1)**	Document
1	A	Means of communication diagram
2	A	Layout of remote control positions
3	A	System of protection against flooding
4	A	Fire detection system: diagram, location and cabling
5	I	Plan of fire detection test for the machinery spaces and vehicle spaces.
(1) A: to be submitted for approval I: to be submitted for information		

3 Fire and flooding precautions

3.1 Fire prevention

3.1.1 The requirements regarding piping and arrangements of fuel oil and lubricating oil systems given in Pt C, Ch 1, Sec 10 are applicable.

3.1.2 Where heating is necessary, it is to be arranged with automatic control. A high temperature alarm is to be fitted in all damage control stations and the possibility of adjusting its threshold according to the fuel quality is to be provided.

3.2 Fire detection

3.2.1 For fire detection, the requirements given in Part C, Chapter 4 are applicable.

3.2.2 An automatic fire detection system is to be fitted in machinery spaces as defined in Pt C, Ch 4, Sec 1, [2] intended to be unattended.

3.2.3 The fire detection system is to be designed with self-monitoring properties. Power or system failures are to initiate an audible alarm distinguishable from the fire alarm in the damage control station.

3.2.4 The fire detection indicating panel is to be located in the damage control station.

3.2.5 The fire detection indicating panel is to indicate the place of the detected fire in accordance with the arranged fire zones by means of a visual signal. Audible signals clearly distinguishable in character from any other signals are to be audible in the damage control station.

3.2.6 Fire detectors are to be of such type and so located that they will rapidly detect the onset of fire in conditions normally present in the machinery space. Consideration is to be given to avoiding false alarms. The type and location of detectors are to be approved by the Society and a combination of detector types is recommended in order to enable the system to react to more than one type of fire symptom.

3.2.7 Except in spaces of restricted height and where their use is specially appropriate, detection systems using thermal detectors only are not permitted. Flame detectors may be installed, although they are to be considered as complementary and are not to replace the main installation.

3.2.8 Fire detector zones are to be arranged in a manner that will enable the operating staff to locate the seat of the fire. The arrangement and the number of loops and the location of detector heads are to be approved in each case. Air currents created by the machinery are not to render the detection system ineffective.

3.2.9 When fire detectors are provided with the means to adjust their sensitivity, necessary arrangements are to be allowed to fix and identify the set point.

3.2.10 When it is intended that a particular loop or detector is to be temporarily switched off, this state is to be clearly indicated. Reactivation of the loop or detector is to be performed automatically after a preset time.

3.2.11 The fire detection indicating panel is to be provided with facilities for functional testing.

3.2.12 The fire detection system is to be continuously powered and is to have an automatic change over to a stand by power supply in case of loss of normal power supply.

3.2.13 The capacity of the battery assuring the continuity of the supply is to be of at least 30 min.

3.2.14 Facilities are to be provided in the fire detecting system to manually release the fire detection alarm from the following places:

- passageways having entrances to engine and boiler rooms
- damage control station.

3.2.15 Spaces where main and auxiliary engines are located, are to be supervised by TV camera monitored from the continuously manned damage control station.

3.2.16 The detection equipment is to be designed so as to signal in less than 3 minutes a conventional seat of fire resulting from a cold smoke generator system in all conditions normally present in machinery spaces. Alternative means of testing may be accepted at the discretion of the Society in order to test the heat and flame detectors.

3.3 Fire fighting

3.3.1 Pressurization of the fire main at suitable pressure by starting main fire pumps and carrying out the other necessary operations is to be possible from the damage control station.

3.3.2 In addition to the fire-extinguishing arrangements mentioned in Part C, Chapter 4, periodically unattended spaces containing steam turbines (whose power is at least 375 kW) are to be provided with one of the fixed fire-extinguishing systems required in the same Chapter for machinery spaces of category A containing oil fired boilers or fuel oil units.

3.4 Protection against flooding

3.4.1 Bilge wells or machinery spaces bilge levels are to be monitored in such a way that the accumulation of liquid is detected in normal angles of trim and heel.

All compartments considered as foldable for the damage stability verification (see Pt B, Ch 3, Sec 3) have to be provided with water level detectors.

3.4.2 Where the bilge pumps are capable of being started automatically, means shall be provided to indicate when the influx of liquid is greater than the pump capacity or when the pump is operating more frequently than would normally be expected.

3.4.3 Where the bilge pumps are automatically controlled, they are not be started when the oil pollution level is higher than accepted in Pt C, Ch 2, Sec 1.

3.4.4 The location of controls of any valve serving a sea inlet, a discharge below the waterline or a bilge injection system shall be so sited as to allow adequate time for operation in case of influx of water to the space, having regard to the time likely to be required in order to reach and operate such controls. If the level to which the space could become flooded with the ship in the fully loaded condition so requires, arrangements shall be made to operate the controls from a position above such level.

3.4.5 Bilge level alarms are to be given in the damage control station.

4 Control of machinery

4.1 General

4.1.1 Under all sailing conditions, including manoeuvring, the speed, direction of thrust and, if applicable, the pitch of the propeller are to be fully controllable from the navigation bridge.

4.1.2 All manual operations or services expected to be carried out with a periodicity of less than 24 h are to be eliminated or automated, particularly for: lubrication, topping up of make up tanks and filling tanks, filter cleaning, cleaning of centrifugal purifiers, drainage, load sharing on main engines and various adjustments. Nevertheless, the transfer of operation mode may be effected manually.

4.1.3 A centralized control position shall be arranged with the necessary alarm panels and instrumentation indicating any alarm.

4.1.4 Parameters for essential services which need to be adjusted to a preset value are to be automatically controlled.

4.1.5 The control system is to be such that the services needed for the operation of the main propulsion machinery and its auxiliaries are ensured through the necessary automatic arrangements.

4.1.6 It is to be possible for all machinery essential for the safe operation of the ship to be controlled from a local position, even in the case of failure in any part of the automatic or remote control systems.

4.1.7 The design of the remote automatic control system shall be such that in the case of its failure an alarm will be given. Unless impracticable, the preset speed and direction of thrust of the propeller it is to be maintained until local control is in operation.

4.1.8 Critical speed ranges, if any, are to be rapidly passed over by means of an appropriate automatic device.

4.1.9 Propulsion machinery is to stop automatically only in exceptional circumstances which could cause quick critical damage, due to internal faults in the machinery. The design of automation systems whose failure could result in an unexpected propulsion stop is to be specially examined. An overriding device for cancelling the automatic shutdown is to be considered.

4.1.10 Where the propulsive plant includes several main engines, a device is to be provided to prevent any abnormal overload on each of them.

4.1.11 Where standby machines are required for other auxiliary machinery essential to propulsion, automatic changeover devices shall be provided.

4.1.12 In the continuously manned control position, it is to be possible to restore the normal electrical power supply in the case of power failure (e.g. with remote control of the generating sets).

4.1.13 In addition to the automatic restart of essential auxiliaries remote control from the continuously manned control position is to be provided.

4.2 Diesel propulsion plants

4.2.1 When a diesel engine is used for the propulsion plant, monitoring and control of equipment is to be performed according to Tab 2 for slow speed engines or Tab 3 for medium or high speed engines.

4.3 Gas turbine propulsion plants

4.3.1 For gas turbines, monitoring and control elements are required according to Tab 4.

Table 2 : Main propulsion slow speed diesel engine

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Main Engine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Stand by Start	Stop
Fuel oil system							
• Fuel oil pressure after filter (engine inlet)	L	R					
						X	
• Fuel oil viscosity before injection pumps or fuel oil temperature before injection pumps (for engine running on heavy fuel)	H + L						
					X		
• Leakage from high pressure pipes where required	H						
Lubricating oil system							
• Lubricating oil to main bearing and thrust bearing pressure	L	R	X				
	LL			X			
						X	
• Lubricating oil to crosshead bearing pressure when separate	L	R	X				
	LL			X			
						X	
• Lubricating oil to camshaft pressure when separate	L						
	LL			X			
						X	
• Lubricating oil to camshaft temperature when separate	H						
					X		
• Lubricating oil inlet temperature	H						
					X		
• Thrust bearing pads or bearing outlet temperature	H	local	X				
• Main, crank, crosshead bearing oil outlet temp. or oil mist concentration in crankcase **(5)**	H		X				
• Flow rate cylinder lubricator (each apparatus)	L		X				
• Level in lubricating oil tanks or oil sump, as appropriate**(4)**	L						
• Lubricating oil to turbocharger inlet pressure	L						
• Turbocharger lubricating oil outlet temperature on each bearing	H						
Piston cooling system							
• Piston coolant inlet pressure	L		X **(1)**				
						X	
• Piston coolant outlet temperature on each cylinder	H	local	X				
• Piston coolant outlet flow on each cylinder **(2)**	L	local	X				
• Level of piston coolant in expansion tank	L						
Sea water cooling system							
• Sea water cooling pressure	L						
						X	

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Main Engine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Stand by Start	Stop
Cylinder fresh cooling water system							
• Cylinder fresh cooling water system inlet pressure	L	local**(3)**	X				
						X	
• Cylinder fresh cooling water outlet temperature or, when common cooling space without individual stop valves, the common cylinder water outlet temperature	H	local	X				
• Oily contamination of engine cooling water system (when main engine cooling water is used in fuel and lubricating oil heat exchangers)	H						
• Level of cylinder cooling water in expansion tank	L						
Fuel valve coolant system							
• Pressure of fuel valve coolant	L						
						X	
• Temperature of fuel valve coolant	H						
• Level of fuel valve coolant in expansion tank	L						
Scavenge air system							
• Scavenging air receiver pressure		R					
• Scavenging air box temperature (detection of fire in receiver, see [3.2.2])	H	local	X				
• Scavenging air receiver water level	H						
Exhaust gas system							
• Exhaust gas temperature after each cylinder	H	R	X				
• Exhaust gas temperature after each cylinder, deviation from average	H						
• Exhaust gas temperature before each turbocharger	H	R					
• Exhaust gas temperature after each turbocharger	H	R					
Miscellaneous							
• Speed of turbocharger		R					
• Engine speed (and direction of speed when reversible)		R					
					X		
• Engine overspeed **(3)**	H			X			
• Wrong way	X						
• Control, safety, alarm system power supply failure	X						

(1) Not required, if the coolant is oil taken from the main cooling system of the engine.
(2) Where outlet flow cannot be monitored due to engine design, alternative arrangement may be accepted.
(3) For engines of 220 KW and above.
(4) If separate lubricating oil tanks are installed, then an individual level alarm for each tank is required.
(5) For engines having a power of more than 2250 kw or a cylinder bore of more than 300 mm.

Table 3 : Main propulsion medium or high speed diesel engine

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Main Engine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Stand by Start	Stop
Fuel oil system							
• Fuel oil pressure after filter (engine inlet)	L	R					
						X	
• Fuel oil viscosity before injection pumps or fuel oil temperature before injection pumps (for engine running on heavy fuel)	H + L						
					X		
• Leakage from high pressure pipes where required	H						
Lubricating oil system							
• Lubricating oil to main bearing and thrust bearing pressure	L	R	X				
	LL			X			
	X					X	
• Lubricating oil filter differential pressure	H	R					
• Lubricating oil inlet temperature	H	R					
					X		
• Oil mist concentration in crankcase **(1)**	H			X			
• Flow rate cylinder lubricator (each apparatus)	L		X				
• Lubricating oil to turbocharger inlet pressure **(2)**	L	R					
Sea water cooling system							
• Sea water cooling pressure	L	R					
						X	
Cylinder fresh cooling water system							
• Cylinder water inlet pressure or flow	L	R	X				
						X	
• Cylinder water outlet temperature	H	R					
			X				
• Level of cylinder cooling water in expansion tank	L						
Scavenge air system							
• Scavenging air receiver temperature	H						
Exhaust gas system							
• Exhaust gas temperature after each cylinder **(3)**	H	R	X				
• Exhaust gas temperature after each cylinder **(3)**, deviation from average	H						
Miscellaneous							
• Engine speed		R					
					X		
• Engine overspeed	H			X			
• Control, safety, alarm system power supply failure	X						

(1) Only for medium speed engines having a power of more than 2250 kw or a cylinder bore of more than 300 mm. One oil mist detector for each engine having two independent outputs for initiating the alarm and shutdown would satisfy the requirement for independence between alarm and shutdown system.
(2) If without integrated self-contained oil lubrication system.
(3) For engine power > 500 kW/cyl.

Table 4 : Propulsion gas turbine

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Turbine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Lubricating oil system							
• Turbine supply pressure	L		X			X	
	LL			X			
• Differential pressure across lubricating oil filter	H						
• Bearing or lubricating oil (discharge) temperature	H						
Mechanical monitoring of gas turbine							
• Speed		R			X		
	H			X			
• Vibration	H						
	HH			X			
• Rotor axial displacement (not applicable to roller bearing)	H						
	HH			X			
• Number of cycles performed by rotating parts	H						
Gas generator monitoring system							
• Flame and ignition failure				X			
• Fuel oil supply pressure	L						
• Fuel oil supply temperature	H + L						
					X		
• Cooling medium temperature	H						
• Exhaust gas temperature or gas temperature in specific locations of flow gas path (alarm before shutdown)	H						
	HH			X			
• Pressure at compressor inlet (alarm before shutdown)	L						
Miscellaneous							
• Control system failure	X						
• Automatic starting failure	X						

4.4 Electrical propulsion plant

4.4.1 Documents to be submitted

The following additional documents are to be submitted to the Society:

- A list of the alarms and shutdowns of the electrical propulsion system
- When the control and monitoring system of the propulsion plant is computer based, a functional diagram of the interface between the programmable logic controller and computer network.

4.4.2 Alarm system

The following requirements are applicable to the alarm system of electrical propulsion:

- Alarms circuits of electrical propulsion are to be connected to the main alarm system on board. As an alternative, the relevant circuit may be connected to a local alarm unit. In any case, a connection between the local alarm unit and the main alarm system is to be provided.
- The alarms can be arranged in groups, and shown in the control station. This is acceptable when a discrimination is possible locally.
- When the control system uses a computer based system, the requirements of Pt C, Ch 3, Sec 4 are applicable, in particular, for the data transmission link between the alarm system and the control system.
- Individual alarms are considered as critical and are to be individually activated at the control stations, and acknowledged individually.
- Shutdown activation is to be considered as an individual alarm.

4.4.3 Safety functions

The following requirements are applicable to the safety system of electrical propulsion:

- As a general rule, safety stop using external sensors such as temperature, pressure overspeed, main cooling failure, stop of converter running by blocking impulse is to be confirmed by the automatic opening of the main circuit using a separate circuit.
- In order to avoid accidental stop of the propulsion line and limit the risk of blackout due to wire break, the tripping of the main circuit-breaker is to be activated by an emission coil with a monitoring of the line wire break.
- In the case of a single line propulsion system, the power limitation order is to be duplicated.
- As a general rule, when the safety stop is activated, it is to be maintained until local acknowledgement.

4.4.4 Transformers

For transformers, parameters according to Tab 5 are to be controlled or monitored.

4.4.5 Converters

For converters, parameters according to Tab 6, Tab 7 and Tab 8 are to be monitored or controlled.

4.4.6 Smoothing coil

For the converter reactor, parameters according to Tab 9 are to be monitored or controlled.

4.4.7 Propulsion electric motor

For propulsion electric motors, parameters according to Tab 10 are to be monitored or controlled.

Table 5 : Transformers

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Motor			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Earth failure on main propulsion circuits	I						
Circuit-breaker, short-circuit	I **(2)**			X			
Circuit-breaker, overload	I **(2)**			X			
Circuit-breaker, undervoltage	I **(2)**			X			
Temperature of winding on phase 1, 2, 3 **(1)**	G						
	I, H		X **(3)**				
	I, HH			X			
Temperature sensor failure (short-circuit, open circuit, supply failure)	G						
Cooling pump pressure or flow	G, L						
			X				
						X	
Cooling medium temperature	G, H			X			
Leak of cooling medium	G						
			X				

(1) A minimum of 6 temperature sensors are to be provided:
- 3 temperature sensors to be connected to the alarm system (can also be used for the redundant tripping of the main circuit-breaker)
- 3 temperature sensors connected to the control unit.

(2) To be kept in the memory until local acknowledgement.
(3) Possible override of slowdown by the operator.

Table 6 : Network converter

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Motor			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Short-circuit current I max	I			X			
Overvoltage	G			X			
Undervoltage	G						
Phase unbalanced	I			(X) **(1)**			
Power limitation failure	I						
Protection of filter circuit trip	I						
Circuit-breaker opening operation failure	I						
Communication circuit, control circuits, power supplies, watchdog of control system according to supplier's design	G			X			
(1) This parameter, when indicated in brackets, is only advisable according to the supplier's requirements.							

Table 7 : Motor converter

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Motor			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Short-circuit current I max	I			X			
Overvoltage	G			X			
Undervoltage	G			X			
Phase unbalanced	I						
Protection of filter circuit trip	I						
Communication circuit, control circuits, power supplies, watchdog of control system according to supplier's design	G			X			
Speed sensor system failure	G					X **(1)**	
Overspeed	I			X			
(1) Automatic switch-over to the redundant speed sensor system.							

Table 8 : Converter cooling circuit

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Motor			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Air cooling temperature high	I	R					
Ventilation, fan failure	G						
			X				
Cooling pump pressure or flow low	G	R					
						X	
Cooling fluid temperature high	G						
Leak of cooling medium	G						
			X				
Temperature sensor failure (short-circuit, open circuit, supply failure)	G						

Table 9 : Smoothing coil

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Motor			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Temperature of coil	I, H	R					
	I, HH						
Air cooling temperature	I, H						
Ventilation fan failure	G						
			X				
Cooling pump pressure or flow low	G	R					
						X	
Cooling fluid temperature high	G						
Leak of cooling medium	G						
			X				
Temperature sensor failure (short-circuit, open circuit, supply failure)	G						

Table 10 : Propulsion electric motor

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Motor			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Automatic tripping of overload and short-circuit protection on excitation circuit	G, H			H			
Loss of excitation	G			X			
Winding current unbalanced	G						
Harmonic filter supply failure	I						
Interface failure with power management system	I		X				
Earthing failure on stator winding and stator supply	I	R					
Temperature of winding on phase 1, 2, 3	G	R					
	I, H		X				
	I, HH			X			
Motor cooling air temperature	I, H	R					
Cooling pump pressure or flow	G,L	R					
			X				
						X	
Cooling fluid temperature	G, H						
Leak of cooling medium	G						
			X				
Temperature sensor failure (short-circuit, open circuit, supply failure)	G						
Motor bearing temperature	G, H	R					
Bearing lubrication oil pressure (for self-lubricated motor, when the speed is under the minimum RPM specified by the manufacturer, shutdown is to be activated)	I, L	R					
			X				
						X	
Bearing lubrication oil pressure	G, L						
Turning gear engaged	I						
Brake and key engaged	I						
Shaft reduction gear bearing temperature	I, H						
Shaft reduction gear lubricating oil temperature	I, H						
Shaft reduction gear bearing pressure	I, L						
				X			

4.4.8 All parameters listed in the tables of this item are considered as a minimum requirement for unattended machinery spaces.

Some group alarms may be locally detailed on the corresponding unit (for instance loss of electronic supply, failure of electronic control unit, etc.).

4.5 Shafting, clutches, CPP, gears

4.5.1 For shafting and clutches, parameters according to Tab 11 are to be monitored or controlled.

4.5.2 For controllable pitch propellers, parameters according t Tab 12 are to be monitored or controlled.

4.5.3 For reduction gears and reversing gears, parameters according to Tab 13 are to be monitored or controlled.

Table 11 : Shafting and clutches of propulsion machinery

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Main Engine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Temperature of each shaft thrust bearing (not applicable for ball or roller bearings)	H		X				
Sterntube bush oil gravity tank level	L						
Clutch lubricating oil temperature	H		X				
Clutch oil tank level	L						

Table 12 : Controllable pitch propeller

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Main Engine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Control oil temperature	H	R					
Oil tank level	L	R					

Table 13 : Reduction gears/reversing gears

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Main Engine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Lubricating oil temperature at the oil cooler outlet	H	R **(1)**	X				
Lubricating oil pressure	L **(1)**	R				X	
	LL			X			
Oil tank level **(2)**	L	R					

(1) May be omitted in the case of restricted navigation notation
(2) May be omitted when the small size of the gearbox makes it unpracticable (low pressure alarm to be representative of a low level in the gearbox casing)

4.6 Auxiliary system

4.6.1 Where standby machines are required for other auxiliary machinery essential to propulsion, automatic change- over devices shall be provided.

Change-over restart is to be provided for the following systems:

- cylinder, piston and fuel valve cooling
- cylinder cooling of diesel generating sets (where the circuit is common to several sets)
- main engine fuel supply
- diesel generating sets fuel supply (where the circuit is common to several sets)
- sea water cooling for propulsion plant
- sea water to main condenser (main turbines)
- hydraulic control of clutch, CPP or main thrust unit
- thermal fluid systems (thermal fluid heaters).

4.6.2 When a standby machine is automatically started, an alarm is to be activated.

4.6.3 When the propulsion plant is divided into two or more separate units, the automatic standby auxiliary may be omitted, when the sub-units concerned are fully separated with regard to power supply, cooling system, lubricating system etc.

4.6.4 Means shall be provided to keep the starting air pressure at the required level where internal combustion engines are used.

4.6.5 Where daily service fuel oil tanks are filled automatically, or by remote control, means shall be provided to prevent overflow spillages.

4.6.6 Arrangements are to be provided to prevent overflow spillages coming from equipment treating flammable liquids.

4.6.7 Where daily service fuel oil tanks or settling tanks are fitted with heating arrangements, a high temperature alarm shall be provided.

4.6.8 For auxiliary systems, the following parameters, according to Tab 14 to Tab 24 are to be monitored or controlled.

Table 14 : Control and monitoring of auxiliary electrical systems

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Main Engine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Electric circuit, blackout	X						
Power supply failure of control, alarm and safety system	X						

Table 15 : Incinerators

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Incinerator			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Stand-by Start	Stop
Combustion air pressure	L			X			
Flame failure	X			X			
Furnace temperature	H			X			
Exhaust gas temperature	H						
Fuel oil pressure	L						
Fuel oil temperature or viscosity , where heavy fuel is used	H + L						

Table 16 : Auxiliary boilers

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Boiler			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Water level	L + H			X	X		
Fuel oil temperature	L + H			X	X		
Flame failure	X			X			
Combustion air supply fan low pressure				X			
Temperature in boiler casing (fire)	H						
Steam pressure	H **(1)**			X	X		
Steam temperature				X **(2)**			

(1) When the automatic control does not cover the entire load range from zero load.
(2) For superheated steam over 330°C.

Table 17 : Fuel oil system

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			System			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Fuel oil tank level, overflow	H **(1)**						
Air pipe water trap level on fuel oil tanks	H **(2)**						
Outlet fuel oil temperature	H **(4)**			X **(5)**	X		
Sludge tank level	H						
Fuel oil settling tank level	H **(1)**						
Fuel oil settling tank temperature	H **(3)**						
Fuel oil centrifugal purifier overflow	H			X			
Fuel oil in daily service tank level	L						
Fuel oil daily service tank temperature	H **(3)**				X		
Fuel oil in daily service tank level (to be provided if no suitable overflow arrangement)	H **(1)**						

(1) Or sight-glasses on the overflow pipe.
(2) Or alternative arrangement as per Pt C, Ch 1, Sec 10.
(3) Applicable where heating arrangements are provided.
(4) Or low flow alarm in addition to temperature control when heated by steam or other media.
(5) Cut off of electrical power supply when electrically heated.

Table 18 : Lubricating oil system

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			System			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Air pipe water trap level of lubricating oil tank See Pt C, Ch 1, Sec 10	H						
Sludge tank level	H						
Lubricating oil centrifugal purifier overflow	H						
(stop of oil supply)							X

Table 19 : Thermal oil system

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			System			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Forced draft fan stopped				X			
Thermal fluid temperature	H						
				X			
Thermal fluid pressure							X
Flow through each element	L			X			
Heavy fuel oil temperature or viscosity	H + L				X		
Burner flame failure	X			X			
Flue gas temperature (when exhaust gas heater)	H			X			
Expansion tank level	L						X **(1)**
(1) Stop of burner and fluid flow.							

Table 20 : Hydraulic oil system

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			System			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Pump pressure	L + H						
Service tank level	L **(1)**						
(1) The low level alarm is to be activated before the quantity of lost oil reaches 100 litres or 50% of the circuit volume, whichever is the lesser.							

Table 21 : Boiler feed and condensate system

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			System			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Sea water flow or equivalent	L					X	
Vacuum	L						
	LL			X			
Water level in main condenser (unless justified)	H + L						
					X		
	HH			X			
Salinity of condensate	H						
Feed water pump delivery pressure	L					X	
Feed water tank level	L						
Deaerator inside temperature or pressure	L + H(**1**)						
Water level in deaerator	L + H						
Extraction pump pressure	L						
Drain tank level	L + H						
(1) In the case of forced circulation boiler.							

Table 22 : Compressed air system

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			System			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Stand-by Start	Stop
Air temperature at compressor outlet	H						
Compressor lubricating oil pressure (except where splash lubrication)	LL			X			
Control air pressure after reducing valves	L + H	R					
					X		
Starting air pressure before main shut-off valve	L **(2)**	local + R **(1)**					
					X		
	X					X	
Safety air pressure	L + H						
					X		

(1) Remote indication is required if starting of air compressor is remote controlled, from wheelhouse for example.
(2) For starting air, the alarm minimum pressure set point is to be so adjusted as to enable at least four starts for reversible propulsion engines and two starts for non-reversible propulsion engines.

Table 23 : Cooling system

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			System			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Sea water pump pressure or flow	X					X	
	L						
Fresh water pump pressure or flow	X					X	
	L						
Level in cooling water expansion tank	L						

Table 24 : Thrusters

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Thruster			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Control oil temperature (preferably before cooler)	H						
Oil tank level	L						

4.7 Control of electrical installation

4.7.1 Where the electrical power can normally be supplied by one generator, suitable load shedding arrangement shall be provided to ensure the integrity of supplies to services required for propulsion and steering as well as the safety of the ship.

4.7.2 In the case of loss of the generator in operation, adequate provision shall be made for automatic starting and connecting to the main switchboard of a standby generator of sufficient capacity to permit propulsion and steering and to ensure the safety of the ship with automatic restarting of the essential auxiliaries including, where necessary, sequential operations.

4.7.3 The standby electric power is to be available in not more than 45 seconds.

4.7.4 If the electrical power is normally supplied by more than one generator simultaneously in parallel operation, provision shall be made, for instance by load shedding, to ensure that, in the case of loss of one of these generating sets, the remaining ones are kept in operation without overload to permit propulsion and steering, and to ensure the safety of the ship.

4.7.5 Following a blackout, automatic connection of the standby generating set is to be followed by an automatic restart of the essential electrical services. If necessary, time delay sequential steps are to be provided to allow satisfactory operation.

4.7.6 Monitored parameters for which alarms are required to identify machinery faults and associated safeguards are listed in Tab 25 and Tab 26. These alarms are to be indicated at the control location for machinery as individual alarms; where the alarm panel with all individual alarms is installed on the engine or in the vicinity, a common alarm in the control location for machinery is required. For communication of alarms detailed requirements are contained in Article [5].

Table 25 : Auxiliary reciprocating I.C. engines driving generators

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Engine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Stand-by Start	Stop
Fuel oil viscosity or temperature before injection	L + H	local					
					X **(4)**		
Fuel oil pressure		local					
Fuel oil leakage from pressure pipes	H						
Lubricating oil temperature	H						
Lubricating oil pressure	L	local				X	
	LL			X **(1)**			
Oil mist concentration in crankcase **(2)**	H			X			
Pressure or flow of cooling water, if not connected to main system	L	local					
Temperature of cooling water or cooling air	H	local					
Level in cooling water expansion tank, if not connected to main system	L						
Engine speed		local					
					X		
	H			X			
Fault in the electronic governor system	X						
Level in fuel oil daily service tank	L						
Starting air pressure	L						
Exhaust gas temperature after each cylinder **(3)**	H						

(1) Not applicable to emergency generator set.
(2) For engines having a power of more than 2250 kW.
(3) For engine power above 100 kW/cyl.
(4) Only when HFO is used

Table 26 : Auxiliary steam turbines

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Turbine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Turbine speed		local					
					X		
	HH			X			
Lubricating oil supply pressure	L					X	
	LL			X			

5 Alarm system

5.1 General

5.1.1 A system of alarm displays and controls is to be provided which readily allows identification of faults in the machinery and satisfactory supervision of related equipment. This is to be arranged at the continuously manned damage control station and at subsidiary control stations and as far as practicable at the machinery local control position if any. In the latter case, a master alarm display is to be provided at the CMCS showing which of the subsidiary control stations is indicating a fault condition.

5.1.2 The alarm system is to be designed to function independently of control and safety systems, so that a failure or malfunction of these systems will not to prevent the alarm system from operating. Common sensors for alarms and automatic slowdown functions are acceptable as specified in each specific table.

5.1.3 The alarm system shall be continuously powered and shall have an automatic change-over to a standby power supply in the case of loss of normal power supply.

5.2 Alarm system design

5.2.1 The alarm system and associated sensors are to be capable of being tested during normal machinery operation.

5.2.2 Insulation faults on any circuit of the alarm system are to generate an alarm, when an insulated earth distribution system is used.

5.2.3 The alarm system is to have a connection to the engineers' public rooms and to each of the engineers' cabins through a selector switch, to ensure connection to at least one of those cabins.

5.2.4 An engineers' alarm is to be activated when the machinery alarm has not been accepted in the machinery spaces or control room within 5 minutes.

5.2.5 Requirements [5.2.3] and [5.2.4] may be omitted for ships where machinery installations are under continuous supervision from the centralized control position. Means to check the operator alertness is to be provided, when alone.

5.3 Machinery alarm system

5.3.1 The local silencing of the alarms in the continuously manned damage control station or subsidiary control stations is not to stop the audible machinery space alarm.

5.3.2 As far as practicable, machinery faults are to be indicated at the control locations for machinery.

5.4 Alarm system

5.4.1 The alarm system is to activate an audible and visual alarm on the navigation bridge for any situation which requires action by or the attention of the officer on watch.

5.4.2 Alarms associated with faults requiring speed reduction or automatic shutdown are to be separately identified on the bridge.

5.4.3 Individual alarms are to be provided at the navigation bridge indicating any power supply failures of the remote control of propulsion machinery.

6 Safety systems

6.1 General

6.1.1 Safety systems of different units of the machinery plant are to be independent. Failure in the safety system of one part of the plant is not to interfere with the operation of the safety system in another part of the plant.

6.1.2 In order to avoid undesirable interruption in the operation of machinery, the system is to intervene sequentially after the operation of the alarm system by:

- starting of standby units
- load reduction or shutdown, such that the least drastic action is taken first.

6.1.3 The arrangement for overriding the shutdown of the main propelling machinery is to be such as to preclude inadvertent operation.

6.1.4 Safeguard disactivation, if provided at the centralised control position, is to be so arranged so that it cannot be operated accidentally; the indication «safety devices off» is to be clearly visible. This device is not to disactivate the overspeed protection.

6.1.5 After stoppage of the propulsion engine by a safety shutdown device, the restart is only to be carried out, unless otherwise justified, after setting the propulsion bridge control level on «stop».

7 Testing

7.1 General

7.1.1 Tests of automated installations are to be carried out according to Pt C, Ch 3, Sec 6 to determine their operating conditions. The details of these tests are defined, in each case, after having studied the concept of the automated installations and their construction. A complete test program is to be submitted for approval and may be as follows:

7.1.2 The tests of equipment carried out alongside under normal conditions of use include, for instance:

- the electrical power generating set
- the auxiliary steam generator
- the automatic bilge draining system
- automatic centrifugal separators or similar purifying apparatus
- automatic change-over of service auxiliaries
- detection of high pressure fuel leaks from diesel generating sets or from flexible boiler burner pipes.

7.1.3 Sea trials are used to demonstrate the proper operation of the automated machinery and systems. For this purpose, for instance, the following tests are to be carried out:

- Test of the remote control of propulsion:
  - checking of the operation of the automatic control system: programmed or unprogrammed starting speed increase, reversal, adjusting of the propeller pitch, failure of supply sources, etc.
  - checking of the crash astern sequence, to ensure that the reversal sequence is properly performed from full away, the ship sailing at its normal operation speed. The purpose of this check is not to control the nautical performances of the ship (such as stopping distance, etc.)
  - finally, checking of the operation of the whole installation in normal working conditions, i.e. as a general rule without watch-keeping personnel for the monitoring and/or running of the machinery during 6 h at least
  - The following procedure may, for instance, be chosen: «underway» during 3 h, then decreasing to «full ahead». Staying in that position during 5 min. Then stopping for 15 min. Then, putting the control lever in the following positions, staying 2 minutes in each one: astern slow, astern half, astern full, full ahead, half ahead, stop, full astern, stop, ahead dead slow, half ahead, then increasing the power until «underway» position.
- Test of the operating conditions of the electrical production:
  - automatic starting of the generating set in the event of a blackout
  - automatic restarting of auxiliaries in the event of a blackout
  - load-shedding in the event of generating set overload
  - automatic starting of a generating set in the event of generating set overload.
- Test of fire and flooding system:
  - Test of normal operation of the fire detection system (detection, system faults)
  - Test of detection in the scavenging air belt and boiler air duct
  - Test of the fire alarm system
  - Test of protection against flooding.
- Test of operating conditions, including manoeuvring, of the whole machinery in an unattended situation for 6 h.

Section 2 Automated Operation in Port (AUT-PORT)

1 General

1.1 Application

1.1.1 The additional class notation **AUT-PORT** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.5.3] to ships fitted with automated installations enabling the ship's operation in port without personnel specially assigned for the watch-keeping of the machinery in service, and complying with the requirements of this Section.

1.1.2 The arrangements provided are to be such as to ensure that the safety of the ship in port is equivalent to that of a ship having the machinery spaces manned.

1.2 Communication system

1.2.1 The requirements of Ch 4, Sec 1, [1.2] are applicable.

2 Documentation

2.1 Documents to be submitted

2.1.1 In addition to the those mentioned in Pt C, Ch 3, Sec 1, Tab 1, documents according to Tab 1 are required.

Table 1 : Documentation to be submitted

No.	I/A(**1**)	Document
1	A	Technical description of automatic engineers' alarm and connection of alarms to remote positions
2	A	System of protection against flooding
3	I	List of machinery to be in operation in port
(1) A: to be submitted for approval I: to be submitted for information.		

3 Fire and flooding precautions

3.1 General

3.1.1 The requirements given in Ch 4, Sec 1, [3] are applicable unless otherwise indicated below.

3.1.2 The remote control of the main fire pumps for the pressurisation of the fire main is to be located at the continuously manned control station in port.

4 Control of machinery

4.1 Plant operation

4.1.1 The machinery and systems which are to be in operation in port are to be designed according to Ch 4, Sec 1, [4], unless otherwise stated.

4.1.2 The requirements of Ch 4, Sec 1 regarding electrical production for propulsion are not applicable.

4.1.3 The operation of auxiliaries, other than those associated with propulsion, is to be designed according to Ch 4, Sec 1.

5 Alarm system

5.1 General

5.1.1 The alarm system is to be designed according to Ch 4, Sec 1, [5], unless otherwise stated in this Section.

5.1.2 The alarm system is to be designed so as to inform of any situation which requires attention of the personnel on watch. For this purpose, an audible and visual alarm is to be activated in the continuously manned control station in port.

6 Location of the continuously manned control station

6.1 General

6.1.1 A CMCS enabling the ship operation in port is to be provided.

6.1.2 However this station may be left unmanned where all monitoring, alarm, safety and control function are transferred to another CMCS located either on another ship or a shore.

7 Testing

7.1 Tests after completion

7.1.1 Tests are to be carried out of all systems which are required to be in operation in port, such as: the fuel oil purifier system, electrical power generation, auxiliary steam generator, etc.

Section 3 Integrated Automation Systems (AUT-IAS)

1 General

1.1 Application

1.1.1 The additional class notation **AUT-IAS** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.5.4] to ships fitted with automated installations enabling periodically unattended operation of machinery spaces and additionally with integrated systems for the control and monitoring of platform systems.

This notation is assigned when the requirements of this Section are complied with in addition to those of Ch 4, Sec 1 for the assignment of the notation **AUT-QAS**.

1.1.2 The design of automation systems, including computer based systems when applicable, is to be such that even when a single failure occurs in the system leading to the loss of the functionality of the service, then a secondary independent means is to be made available to restore the functionality of the service.

1.1.3 The need of redundancy of subsystems, I/O sensors and final actuators is to be evaluated on a case by case basis.

2 Documentation

2.1 Documents to be submitted

2.1.1 In addition to the those mentioned in Pt C, Ch 3, Sec 1, Tab 1 and Ch 4, Sec 1, Tab 1, documents listed in Tab 1 are to be submitted.

Table 1 : Documents to be submitted

No.	I/A(**1**)	Document
1	I	Block diagram of the integrated computer based systems
2	A	FMEA study
2	I	Description of the data transmission protocol
3	I	Description of the auto-diagnosis function
(1) A: to be submitted for approval I: to be submitted for information.		

3 Design requirements

3.1 General

3.1.1 The computer network is to be capable of supporting all the integrated subsystems ensuring the minimum performance required in Pt C, Ch 3, Sec 3.

3.1.2 Consequences of a possible fault are to be taken into account. Normally, no consideration is given to defects occurring simultaneously; however in the case of defects which would remain undetected, it might be necessary to take into consideration the adding of several independent defects.

3.1.3 Necessary arrangements are to be made to avoid interaction between the various automatic control circuits in the event of a fault in one of them (e.g. galvanic separation of automatic control electric circuits or earth leak monitoring device with possibility of disconnecting the faulty circuit, keeping the others in service).

3.1.4 Arrangements are to be made to avoid self-oscillation of these automatic control devices; their natural frequencies are to be sufficiently far from those of the controlled installation to avoid resonance.

3.1.5 Sequential controls are to ensure checking of the condition necessary for automatic starting of main and auxiliary machinery. If one of these conditions is not fulfilled, the starting process is to be locked. A new starting attempt may be allowed only after returning to a steady and safe position.

3.1.6 To determine the operating conditions of the sequences, transducers are to check the parameter resulting from each step. The use of simple time delays for controlling the sequences is to be limited to cases where they can previously be clearly defined.

3.2 Integrated computer based systems

3.2.1 The following requirements apply in addition to those in Pt C, Ch 3, Sec 3 and Ch 4, Sec 1.

3.2.2 In addition to the requirements of Pt C, Ch 3, Sec 3 the computer network is to be single fault tolerant.

3.2.3 The integrated automation system is to be designed such that the subsystem is still operating in the case of loss of transmission of the network.

3.2.4 A document is to be issued when a modification of the configuration of the integrated system is carried out.

3.2.5 In case of failure of one computer server on which software is resident, at least another computer server is to be available.

3.2.6 In the case of failure of one workstation, the corresponding functions are to be possible from at least another work station in the same location, without a stop of the system in operation.

4 Testing

4.1 Additional testing

4.1.1 In addition to those required in Ch 4, Sec 1, the following additional tests are to be carried out along side or at sea where necessary:

- checking of the fire detection system
- checking of the proper operating condition of the integrated computer based systems used for monitoring and control and, in particular:
  - visual inspection
  - functional operation of workstation
  - transfer of control of workstation
  - inhibition function of alarms
  - alarm acknowledgement procedure
  - simulation of internal and external failure of the integrated system, including loss or variation of power supply
  - wrong data insertion test.

CHAPTER 5
MONITORING EQUIPMENT (MON)

Section 1 Hull Stress and Motion Monitoring (MON-HULL)

1 General

1.1 Application

1.1.1 The additional class notation **MON-HULL** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.7.2] to ships equipped with a Hull Stress and Motion Monitoring System (hereafter referred to as Hull Monitoring System for easy reference), complying with the requirements of this Section.

1.1.2 A Hull Monitoring System is a system which:

- provides real-time data to the Captain and the Officers of the ship on hull girder longitudinal bending moments and motions the ship experiences while navigating and during loading and unloading operations in harbour (notation: **MON-HULL**)
- optionally, allows the storage of real-time data and/or of a set of statistical results.

The stored information should be organized in view of a later exploitation by the Owner, for instance as an additional element in the exploitation and maintenance of the ship or as an addition to her logbook. This option is distinguished by the additional class notation **+S**, the notation becoming **MON-HULL+S**.

Note 1: The information provided by the Hull Monitoring System is to be considered as an aid to the Captain. It does not replace his own judgement or responsibility.

1.2 Documentation

1.2.1 The following documents are to be submitted to the Society for approval:

- specification of the main components: sensors, processing units, display unit, storage unit, power supply and cabling
- functional scheme of the system
- principles and algorithm used for the data processing, either in **MON-HULL** or in **MON-HULL+S**
- determination of measurement ranges
- determination of data limits
- initial calibration procedure including calibration values and tolerances
- procedure for the periodical checks.

1.3 Data limits, warning levels

1.3.1 The information provided by the transducers is to be compared against relevant limits corresponding to maximum values obtained from the requirements on the basis of which the hull structure is approved. When a limit is reached, an alarm is to be issued.

1.3.2 The above information can also be compared against warning levels determined by the Owner.

A warning level is always to be less than the corresponding alarm level mentioned in [1.3.1].

When a warning level is reached, a signal is to be emitted, different from the alarm mentioned in [1.3.1].

2 Hull monitoring system

2.1 Main functions

2.1.1 The Hull Monitoring System is to be able to ensure the following main functions:

- collection of data
- data processing: scaling, consistency checks, statistical processing when needed by the plain **MON-HULL** implementation
- management of the displays, handling of the alarms and warnings
- in **MON-HULL+S**: selection, compression, if any, and storage of the information.

Note 1: The resources needed for the later onshore exploitation of the recorded results need not be considered as part of the Hull Monitoring System, provided that they cannot have access to the storage medium in order to modify the content.

2.2 Sensors

2.2.1 The sensors are to consist of a set of devices able to provide at least:

- indirect information on the longitudinal bending moment of the hull, at least at one location where the maximum hull girder normal stress can be expected during navigation, loading and unloading
- information on the vertical acceleration at the bow

  If a consistent monitoring of the vertical acceleration in any point of the hull girder is required, vertical acceleration is also to be collected at the stern
- information on the transverse acceleration due to the roll and the heel.

2.2.2 Attention is drawn to the possible existence of local strains induced by temperature gradients in the hull structure.

The strain sensors are to be located in areas free from these temperature gradients.

If a temperature compensation device is implemented, the Manufacturer is to demonstrate its effectiveness on site.

2.2.3 The sensors are to comply with the applicable requirements concerning protection against conducted and radiated electric and radioelectric emissions.

2.2.4 The sensors are to be selected and installed in such a way that a periodical on-site check can be carried out without extra equipment.

When this operation is impossible, the Manufacturer is to declare what are the period and procedure for a shop recalibration and demonstrate that the calibration remains valid within the period.

2.3 Specifications

2.3.1 For each type of measurement, the Manufacturer is to state the limits of the domain, according to the ship.

The limits are to include:

- the strain ranges
- the acceleration ranges
- the corresponding frequency range
- the temperature ranges: sea water, open air, hull structure, sheltered, accommodation.

2.3.2 The global resolution of the instrument is to be such that the uncertainty as to the displayed information is less than 7% of its full scale display. The global resolution applies on the entire domain, display included; the specification of the components is to be set accordingly.

2.3.3 The system is to be able to detect and signal the malfunctions which can impair the validity of the data, e.g.:

- data are out of range
- data remain strictly constant
- data are corrupted by high intensity noise
- the system stops or hangs.

2.4 Real time data processing

2.4.1 Wave-induced data are to be processed through any convenient procedure (maximum peak value, root mean square, mean value, frequency spectrum, etc.) selected in order that the displayed information is significant, not confusing, immediately understood and as close as possible to the nautical experience of the crew.

The procedure is to produce smoothed results that are not to deviate by more than 10% from one cycle to the next when in steady navigation conditions.

The procedure is to be such that a significant aggravation in the navigation conditions appears on the display after no more than three cycles.

The system is to switch automatically from port to sea conditions, and vice versa.

2.4.2 Provision is to be made for a transfer of information to a Voyage Data Recorder where this is fitted on board, according to the standards of the Voyage Data Recorder.

2.5 Visual display

2.5.1 A graphical display is to be fitted, with the following features:

- it is to be simple, clear and non-confusing
- the user is to be able to obtain the information through one reading
- it is to be readable at a distance of at least 0,5 m
- two major pieces of information (e.g. stress and/or vertical acceleration at bow) are declared as “default conditions” and displayed at power up and before the user takes any action
- when an alarm is emitted, the corresponding information is to be displayed instead of the above “default conditions”.

2.5.2 When the system detects a malfunction, the corresponding status is to be superimposed on the display.

2.6 Alarms

2.6.1 For each limit stated in [1.3.1], visual and audible alarms are to be fitted on the bridge to indicate when the limit is approached and exceeded.

The alarms associated with each limit are to be clearly distinguishable from those relevant to other limits.

2.6.2 When a warning level is reached (see [1.3.2]), a visible signal is to be issued, distinct from those of the alarms for limits stated in [2.6.1].

2.6.3 When the system detects a malfunction, the alarms and warnings associated with the data are to be inhibited and a malfunction alarm is to be issued (see also [2.5.2]).

2.7 Data storage (MON-HULL+S)

2.7.1 The real time data are to be stored either by a recording device which is part of the Hull Monitoring System, according to [2.7.2] to [2.7.4], or by the integrated bridge system, if any.

2.7.2 An electronic data storage recording device suitable for accumulating statistical information for feedback purposes is to be fitted.

2.7.3 The data storage recording device is to be:

- entirely automatic, excluding replacement operations of the storage support
- such that its operation does not interrupt or delay the process of collecting and processing data.

2.7.4 Data are to be recorded with information on the date and time.

2.8 Exploitation and checking of stored data (MON-HULL+S)

2.8.1 The data stored according to [2.7] are to be processed by the Owner through a statistical process.

2.8.2 Periodicity of exploitation of data is to be defined by the Owner depending on the ship’s operation.

2.8.3 Means are to be incorporated which ensure that the integrity of the collected data can be checked at the exploitation stage.

2.9 Power supply unit

2.9.1 The Hull Monitoring System is to be powered by the main power source of the ship and in addition with an internal uninterruptible 30 minute power source.

2.10 Calibration

2.10.1 The initial calibration of indirect information of the bending moment is to be based on an approved loading case in still water.

The differences between results obtained from the Hull Monitoring System and approved values are to be less than 5%.

2.10.2 The initial calibration of the Hull Monitoring System is to be carried out with a Surveyor in attendance.

2.11 Periodical inspections

2.11.1 Checks of the main functions of the Hull Monitoring System are to be carried out at intervals as agreed by the Society and not exceeding one year.

The instrument is to include an auto-checking facility so that the verification of the Hull Monitoring System can be carried out without the need of external devices.

Section 2 Shaft Monitoring (MON-SHAFT)

1 General

1.1 Applicability of MON-SHAFT notation

1.1.1 The additional class notation **MON-SHAFT** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.7.3], to ships fitted with oil or water lubricated systems for tailshaft bearing complying with the requirements of this Section.

1.1.2 The assignment of this notation allows a reduced scope for complete tailshaft surveys (see Pt A, Ch 2, Sec 2, [6.6.4]).

1.1.3 The requirements of this section apply in addition to those listed in Pt C, Ch 1, Sec 7, [2.4].

1.2 Documentation to be submitted

1.2.1

The plans and documents to be submitted for the additional class notations MON-SHAFT are listed in Tab 1 for oil lubricated shafts, and in Tab 2 for water lubricated shafts.

Table 1 : Documentation to be submitted for oil lubricated shafts

N°	A/I **(1)**	Documents
1	A	Shaft line arrangement
2	A	Oil sealing gland
3	I	Onboard procedure for measurement of bearing wear, oil sealing gland seals replacement and lubricating oil analysis, including records
(1) A= to be submitted for approval I = to be submitted for information		

Table 2 : Documentation to be submitted for water lubricated shafts

N°	A/I **(1)**	Documents
1	A	Shaft line arrangement
2	A	Sealing gland
3	A	Water lubrication piping diagram
4	I	Arrangement and procedure to measure the bearing wear
5	A	Shaft alignment calculation (see [3.1.6])
6	I	Onboard procedure for sealing gland seals replacement
(1) A= to be submitted for approval I = to be submitted for information		

2 Requirements for oil lubricated shafts

2.1 Arrangement

2.1.1 Oil sealing glands design is to be approved by the Society. Seals replacement is to be possible without shaft withdrawal.

2.1.2 A temperature sensor for each bearing or other approved arrangements are to be provided. In particular, the aftmost bearing is to be fitted with a temperature monitoring system.

2.1.3 The aftmost bearing is to be arranged with facilities for measurement of bearing wear.

2.2 Lubricating oil analysis

2.2.1 Analysis frequency

Provisions are to be made to analyse stern bearing lubricating oil on a regular basis; in any event, the interval between two subsequent analyses is not to exceed six months.

2.2.2 Records

Provisions are to be made to make the lubricating oil analysis documentation available on board showing in particular the trend of the parameters measured according to [2.2.3].

2.2.3 Content of analysis

Each analysis is to include the following parameters:

- water content
- chloride content
- bearing material and metal particle content
- oil ageing (resistance to oxidation).

The oil samples are to be taken under service conditions and are to be representative of the oil within the sterntube sterntube.

2.2.4 Additional data to be recorded

In addition to the results of the oil sample analysis, provisions are to be made to record the following data on a regular basis:

- oil consumption
- bearing temperatures (a temperature sensor for each bearing or other approved arrangements are to be provided).

3 Requirements for water lubricated shafts

3.1 General requirements

3.1.1 Bearing material is to be approved by the Society.

3.1.2 The tailshaft is to be made of a corrosion-resistant material or protected against corrosion by a continuous liner or cladding

3.1.3 The bearings are to be arranged with facilities for measuring the bearing wear while the ship is afloat. The relevant procedure including the maximum permissible wear will have to be submitted.

3.1.4 Sensors are to be provided for the aft bearing and any other bearings not accessible when the ship is afloat, giving alarm in case of bearing wear exceeding a predetermined threshold. An alarm is to be activated in the event of failure of the position sensor circuit.

3.1.5 Alternatively, arrangements are to be made for endoscopic examination of the tailshaft surface in particular in way of the bearings with the shaft in place. The relevant procedure will have to be submitted to the Society.

3.1.6 Where required by Pt C, Ch 1, Sec 7, [3.3], the shaft alignment calculations are to be performed for both initial conditions (new bearings) and conditions of maximum permissible wear according to the bearing manufacturer’s recommendations and deemed satisfactory by the Society.

3.1.7 Sealing glands design is to be approved by the Society. Replacement of seals is to be possible without withdrawal of tailshaft.

3.2 Additional requirements for forced water lubrication systems

3.2.1 The water pumping system is to include:

- two pumps
- a filtering system designed in accordance with bearing and pump manufacturer requirements
- two independent flow sensors allowing permanent flow monitoring and activating an alarm in case of low flow.

Note 1: Where two shaft lines are installed, it is acceptable to have a single pump per shaft line, provided the safety of the ship is not impaired with one pump disabled. Special attention is to be paid to the applicable requirements when the ship is to be assigned an AVM additional class notation.

3.2.2 The operating restrictions of the propulsion installation in case of low flow alarm are to be stated.

3.2.3 Filters are to be cleaned or replaced in accordance with manufacturer recommendations. Records of cleaning and replacement of filters are to be available onboard.

3.2.4 Unless otherwise justified, an interlock arrangement is to be provided to prevent the propulsion starting if sufficient water flow is not established.

3.3 Data to be recorded

3.3.1 The following data are to be regularly recorded and available on board:

- water flow
- bearings wear
- failure alarms.

Part E
Additional Class Notations

CHAPTER 6
COMFORT ON BOARD (COMF)

Section 1 General Requirements

1 General

1.1 Application

1.1.1 The following additional class notations are assigned, in accordance with Pt A, Ch 1, Sec 2, [6.8], to naval ships complying with the applicable requirements of the present Chapter:

- **COMF-NOISE** with regard to noise criteria
- **COMF-VIB** with regard to vibration criteria.

Both class notations may be assigned separately.

The requirements corresponding to those additional class notations are given in Ch 6, Sec 2 and Ch 6, Sec 3.

1.1.2 Special requirements

Special requirements related to the specific activities and/or missions of the ship are not covered by these Rules. The following additional class notation only considers noise/vibration sources connected with the ship platform.

1.2 Basic principles

1.2.1 The comfort class grade is granted on the basis of measurements performed by an acoustic and vibration specialist from the Society during building stage, sea trials or in service.

However, measurements may be performed by another acoustic and vibration specialist from external company provided that this specialist has duly obtained the relevant delegation from the Society.

1.2.2 These Rules take into account several International standards and are deemed to preserve their general principles.

1.3 Regulations - Standards

1.3.1 The present chapter refer to the following standards applicable to noise:

- IMO Resolution MSC.337(91) "Adoption of the Code on noise levels on board ships"
- ISO 2923 "Acoustic: Measurements of noise on board vessels"
- ISO 31/VII "Quantities and units of acoustics"
- IEC Publication 61672 "Electroacoustics - Sound level meters"
- IEC Publication 61260 "Octave, half-octave and third octave band filters"
- IEC Publication 60942 "Electroacoustics - Sound calibrators"
- ISO 140 "Acoustics - Measurements of sound insulation in buildings and of building elements", namely:
  Part 14 - 2004, "Guidelines for special situation in field"
- ISO 16283-1 "Acoustics - Field measurement of sound insulation of buildings and of building elements - Part 1: Airborne sound insulation"
- ISO 717 "Acoustics - Rating of sound insulation in buildings and of building elements", namely:
  Part 1 - 1997, "Airborne sound insulation in buildings and interior elements".
- ISO 1996 "Acoustics - Description, measurements and assessment of environmental noise", namely:
  - Part 1 "Basic quantities and assessment procedure"
  - Part 2 "Determination of environmental noise levels"

1.3.2 The present Chapter refer to the following standards applicable to vibrations:

- ISO 2041 "Vibration and shock - Vocabulary"
- ISO 6954 "Mechanical vibration and shock - Guidelines for the overall evaluation of vibration in merchant ships"
- ISO 2631 "Mechanical vibration and shock - Evaluation of human exposure to whole-body vibration"
- ISO 8041 "Human response to vibration – Measuring instrumentation".

1.4 Documentation to be submitted

1.4.1 Prior to the trials, some documents are to be submitted, as listed in Tab 1.

Table 1 : Documents to be submitted

No.	A/I **(1)**	Documents
1	I	General arrangements
2	A	Measurement program: • loading conditions • propulsion operating conditions • other equipment to be run • weather conditions • measuring instruments
(1) A: to be submitted for approval ; I: to be submitted for information		

2 Conditions of attribution

2.1 Measurements

2.1.1 Measurements aiming at giving the comfort class notation are to be performed under the conditions specified in Article [3].

2.1.2 Measurement and calibration equipment are to meet the requirements of ISO 2923, IEC 61672-1, IEC 61260 and IEC 60942 for noise, and ISO 2631 and ISO 8041 for vibration.

Sound insulation measurements are to be carried out according to ISO 16283-1 and ISO 140-14.

Noise and vibration calibrators are to be verified at least every year. Measuring equipment are to be verified at least every two years. This verification shall be done by a national standard laboratory or a competent laboratory accredited according to ISO 17025 (2005) as corrected by (Cor 1:2006).

2.1.3 When it is not possible for the Society to follow or to do all the required measurements, spot-check is to be performed by the Society. This spot-check consists of a cross-comparison between:

- a sample of at least 10% of the measurements provided by the shipyard/external specialist

Note 1: The maximum deviations allowed during the cross-comparison are 2 dB(A) for noise measurements and 0,3mm/s for vibration measurements for overall frequency weighted RMS readings.

- and the corresponding readings obtained during the spot-check measurements.

This procedure enables the validation of the entire set of measurements provided by the shipyard/external specialist.

2.2 Acceptance criteria

2.2.1 The **COMF-NOISE** notation is assigned on condition that none of the measured values exceeds the limits given in Ch 6, Sec 2, Tab 1 and Ch 6, Sec 2, Tab 2. A tolerance on noise levels may be accepted but shall not exceed the following maximum values:

- 3 dB(A) for 25% and 5 dB(A) for 5% of the measuring points
- 1 dB for 20% and 2 dB for 10% of apparent weighted sound reduction indexes R'w (with a minimum of one partition).

The **COMF-VIB** notation is assigned on condition that none of the measured values exceeds the limits given in Ch 6, Sec 3, Tab 1. A tolerance on vibration levels may be accepted but shall not exceed 0,3 mm/s for 20% of measuring points for overall frequency weighted r.m.s. velocity criteria.

2.3 Measuring locations

2.3.1 Measurements are to be carried out in each type of space, if existing, specified in Ch 6, Sec 2, Tab 1 according to the following principles:

- at least 30% of the cabins and all cabins adjacent to engine casing or machinery spaces
- all mess rooms and recreational spaces
- all spaces permanently manned in normal operational conditions

For spaces larger than $50m^2$, two measurements are to be taken conveniently spaced.

The measurement locations are to be chosen to assure a good representation of the overall noise and vibration environment on board.

The list of measuring points is to be prepared prior to the tests by the Society or the external company (see [1.2.1]). This list may be adjusted during the tests.

3 Testing conditions

3.1 General

3.1.1 This Article gives the conditions to be fulfilled during measurements. Additional details of these conditions may be taken from International Standards, namely:

- IMO Resolution MSC.337(91), ISO 2923 for noise
- ISO 6954 for vibrations.

3.1.2 Prior to the tests, possible divergence on the required conditions may be accepted by the Society. If any, it is to be clearly mentioned in the report.

3.1.3 The measurement program has to be approved before the trials (see [1.4.1]). During the tests, some additional measurements may be decided upon request of the Society.

3.1.4 During measurements, especially for noise, rooms have to be preferably fully completed (outfitting, furniture, covering...). Measurements may be performed even in an unfinished state, which generally suppose better final results.

3.2 Harbour test conditions

3.2.1 The sound insulation measurements are to be conducted at quay or at anchorage. For these specific tests, measurements should preferably be performed without machinery, ventilation or air conditioning running.

3.3 Sea trial conditions

3.3.1 Propulsion plant power

During the measurements, propeller output is to correspond to the operating conditions specification of the ship and not less the 80% of the maximum continuous rating (MCR) unless other conditions are specified by the Naval Authority.

Ships which are frequently operated by means of a Dynamic Positioning system (DP system) shall require additional measurements to be performed in DP mode. The Owner, Shipyard and Society shall agree on a process to simulate the operation of the DP thruster system under conditions which would approximate station-holding at, or above, 40 per cent of maximum thruster power for design environmental conditions that the ships operates in.

3.3.2 Auxiliaries

During measurements, forced ventilation and air conditioning system (HVAC systems) are to be operating, as well as auxiliary systems used in normal service condition. Any other frequently used equipment (more than 1/3 of the time at sea) is to be run at its normal operating conditions (if practicable.

3.3.3 Human activity

- During measurements, noise arising from every kind of unnecessary human activity is to be avoided as far as possible.
- To this end only the personnel needed for the normal operation of the ship and those carrying out the measurements are to be present.

3.3.4 Ship course

Ship course has to be kept constant, with rudder angle less than 2 degrees portside or starboard, for the duration of the measurement. If ship manoeuvring is needed, measurements must be stopped until recovery of heading

3.3.5 Water depth

Water depth is greater than 5 times the mean ship draught.

3.3.6 Meteorological conditions

Tests have to be conducted in sea and weather condition 3 or less. Measurements carried out with worst weather conditions may be accepted at the sight of the results.

Section 2 Additional Requirements for Notation COMF-NOISE

1 General

1.1 Application

1.1.1 The requirements of this Section are applicable when the additional class notation **COMF-NOISE** is assigned. They are additional to the applicable requirements of Ch 6, Sec 1.

2 Measurement procedure

2.1 Instrumentation

2.1.1 The instrumentation is to be calibrated in situ, before and after the tests, and is to include one third octave band filter (see Ch 6, Sec 1, [2.1.2]). The instrument is to be able to give LAeq measurements.

2.2 Data processing - Analysis

2.2.1 The nominal noise level is evaluated with LAeq,T value. LAeq,T (dB(A) re. 20 μPa) is the equivalent continuous A weighted sound pressure level, T greater than 20 seconds. Results are to be given on table in global values (dB(A)). Upon request of the Society or his representative, they may have to be presented in a table giving the third octave band analysis.

2.2.2 To evaluate the required privacy inside accommodations, the apparent weighted sound reduction index R'w is to be calculated. R'w (dB) is a field measure of airborne sound insulation between rooms. This index is to be determined in accordance with ISO 717-1 and ISO 16283-1.

2.3 Measuring condition

2.3.1 Tests are to be conducted in the conditions described in Ch 6, Sec 1, [3]. Air conditioning is to be in normal operation. Doors and windows are to be closed, unless they are kept open in normal use.

Measurements are to be conducted with all equipment in normal operating conditions.

2.4 Measuring positions

2.4.1 Measurements are to be taken at a height between 1,2 m and 1,6 m from the deck and at a distance above 1,0 m from any boundary surface of the room. In cabins and offices, one measurement will be performed in the middle of the space. The measurement is to be taken at 2,0 m at least from the existing noise sources (e.g. inlet/outlet of air conditioning openings). The selection of noise level measuring locations is indicated in Ch 6, Sec 1, [2.3]. Three measuring points are to be carried out in the wheelhouse (centre line and both sides).

2.4.2 The insulation measurements location have to fulfil the recommendations of ISO 140-14.

The selection of sound insulation measuring locations is to be representative of the different types of insulation provided in Tab 2 (a minimum of two measurements of each insulation type is required).

3 Noise levels and sound insulation measurement

3.1 Noise level requirements

3.1.1 For each space typology, maximum noise levels are given in Tab 1 unless otherwise specified by the Naval Authority.

3.2 Sound insulation measurement

3.2.1 Between two adjacent accommodation spaces, apparent weighted sound reduction index R’w is to be higher than the requirements given in Tab 2. Measurements are to be performed in situ.

Table 1 : Noise level requirements

Location	LAeq,T (dB(A))
Wheelhouse	65
Operational rooms	60
Cabins	60
Offices	65
Recreational spaces	65
Mess Rooms	65
Hospital	60
Galleys (without food processing equipment operating)	75
Workshop, laundries (without equipment operating)	85
Engine control room	75

Table 2 : Apparent weighted sound reduction indexes R’w

Walls between cabins and	R’w (dB)
Cabin	30
Corridor	30
Recreational room, mess room, public spaces	45

Section 3 Additional Requirements for Notation COMF-VIB

1 General

1.1 Application

1.1.1 The requirements of this Section are applicable when the additional class notation **COMF-VIB** is assigned. They are additional to the applicable requirements of Ch 6, Sec 1.

2 Measurement procedure

2.1 Instrumentation

2.1.1 The instrumentation is to be calibrated in situ, before and after the tests (see Ch 6, Sec 1, [2.1.2]).

The instrumentation is to include at least a transducer (accelerometer or velocity transducer) with an appropriate amplifier, and a FFT analyser.

Should the vibration measurements be performed on a soft floor, the use of a rigid plate with the person standing on the plate and the accelerometer rigidly fixed on is recommended.

2.2 Data processing, presentation of results and analysis

2.2.1 The criterion of vibration is to be expressed in terms of overall frequency-weighted r.m.s. velocity (mm/s) from 1 to 80 Hz as defined by ISO 6954:2000.

2.3 Measuring conditions

2.3.1 Tests are to be conducted in the conditions described in Ch 6, Sec 1, [3]

Measurements are to be conducted with all equipment in normal operating conditions.

2.4 Measuring positions

2.4.1 Measurements are to be taken in vertical direction. In cabins, offices or other small size rooms, measurements are to be taken on the floor in the centre of the room. For larger rooms, several measuring points may be required and are to be chosen according to the local structure (measurements of the different existing types of stiffened panels).

Three measuring points are to be carried out in the wheelhouse (centre line and both sides).

In addition to vertical direction, measurements in transverse and longitudinal directions are to be performed on one point on each deck.

3 Vibration level requirements

3.1 General

3.1.1 Vibration level requirements are provided in Tab 1 in accordance with ISO 6954-2000. The limits listed in Tab 1 are applicable for any directions.

Table 1 : Overall velocity level requirements

Space	Vibration velocity values (mm/s) / values from 1 Hz to 80 Hz
Wheelhouse	3,2
Operational rooms	3,2
Cabins	3,2
Offices	4,0
Recreational spaces	4,0
Mess Rooms	4,0
Hospital	3,2
Galleys (without food processing equipment operating)	6,0
Workshop, laundries (without equipment operating)	6,0
Engine control room	6,0

Part E
Additional Class Notations

CHAPTER 7
ENVIRONMENTAL PROTECTION (CLEANSHIP)

Section 1 General Requirements

1 Scope and application

1.1 General

1.1.1 This Chapter contains the requirements for additional class notations related to environmental protection .

1.1.2 These additional class notations include:

- **CLEANSHIP** and **CLEANSHIP SUPER** notations
- other notations having a specific scope and listed in Tab 1.

For the assignment of the **CLEANSHIP SUPER** notation, at least three notations among those referred to as "eligible" in Tab 1, column 4, are also to be assigned.

The relevant symbol, scope, reference to the Rules and assignment conditions are given in Tab 1.

Examples of notations are given below:

- **CLEANSHIP**
- **CLEANSHIP**, **BWE**
- **CLEANSHIP SUPER (AWT, NOX-80%, SOX-60%)**
- **OWS-5 ppm**
- **AWT**, **NDO-2 days**

1.2 National regulations

1.2.1 Additional requirements may be imposed by the Naval Authority and/or by the State or Port Administration in the jurisdiction of which the ship is intended to operate, in particular with respect to:

- exhaust gas smoke (particulate emissions, smoke opacity)
- fuel oil sulphur content
- bilge water oil content
- on board waste incineration.

Table 1 : Additional class notations for the prevention of pollution

Symbol	Scope	Reference to the Rules	Eligible for the assignment of **CLEANSHIP SUPER** notation	Assignment conditions
CLEANSHIP	Prevention of sea and air pollution	Ch 7, Sec 2, [2]	N/A	
CLEANSHIP SUPER	Prevention of sea and air pollution	Ch 7, Sec 2, [2] Ch 7, Sec 2, [3]	N/A	At least 3 eligible notations are to be assigned
AWT	Fitting of an Advanced Wastewater Treatment plant	Ch 7, Sec 3, [2]	Yes	
BWE	The ship is designed for ballast water exchange in accordance with the technical provisions of BWM Convention (2004), Regulation D-1	Ch 7, Sec 3, [3]	No	
BWT	Fitting of a ballast water treatment plan	Ch 7, Sec 3, [4]	Yes	
GREEN PASSPORT	Hazardous material inventory	NR528	No	
GWT	Fitting of a treatment installation for Grey Waters	Ch 7, Sec 3, [5]	Yes	
NDO-x days	The ship is designed for No Discharge Operation during x days	Ch 7, Sec 3, [6]	Yes	
NOX-x%	Average NOx emissions of engines not exceeding x% of IMO Tier II limit	Ch 7, Sec 3, [7]	Yes	
Note 1: N/A = not applicable.				

Symbol	Scope	Reference to the Rules	Eligible for the assignment of **CLEANSHIP SUPER** notation	Assignment conditions
OPS( )	Fitting of an Onshore Power Supply (or Shore connection)	NR467, Pt F, Ch 14, Sec 4	Yes	
OWS-x ppm	Fitting of an Oily Water Separator producing effluents having a hydrocarbon content not exceeding x ppm (parts per million)	Ch 7, Sec 3, [8]	Yes	
SOX-x%	Oil fuels used within and outside SECAs have a sulphur content not exceeding x% of the relevant IMO limit	Ch 7, Sec 3, [9]	Yes	
Note 1: N/A = not applicable.				

2 Definitions and abbreviations

2.1 Definitions related to sea pollution

2.1.1 Hazardous wastes

Hazardous wastes are those wastes composed of substances which are identified as marine pollutants in the International Maritime Dangerous Goods Code (IMDG Code).

Hazardous wastes include in particular:

- photo processing chemicals
- dry cleaning waste
- used paints
- solvents
- heavy metals
- expired chemicals and pharmaceuticals
- waste from printers
- hydrocarbons and chlorinated hydrocarbons
- used fluorescent and mercury vapour light bulbs
- batteries.

Note 1: Empty packagings previously used for the carriage of hazardous substances are considered as hazardous substances.

2.1.2 Wastewater

Wastewater includes both sewage and grey water as defined in [2.1.3] and [2.1.5].

2.1.3 Sewage

Sewage means:

- drainage and other wastes from any form of toilets, urinals, and WC scuppers, here designated as black waters
- drainage from medical premises (dispensary, sick bay, etc.) via wash basins, wash tubs and scuppers located in such premises
- drainage from spaces containing live animals, or
- other waste waters when mixed with the drainages defined above.

2.1.4 Sewage sludge

Sewage sludge means any solid, semi-solid, or liquid residue removed during the treatment of on-board sewage.

2.1.5 Grey water

Grey water includes drainage from dishwashers, showers, sinks, baths and washbasins, laundry and galleys.

2.1.6 Garbage

Garbage means all kinds of victual, domestic and operational waste excluding fresh fish and parts thereof, generated during the normal operation of the ship and liable to be disposed of continuously or periodically, except those substances which are defined or listed in Annexes I, II, III and IV to MARPOL 73/78.

Garbage includes all kinds of solid wastes like plastics, paper, oily rags, glass, metal, bottles, and incinerator ash. Food wastes are considered as garbage.

2.1.7 Oil residue (sludge)

Oil residue (sludge) means the residual waste oil products generated during the normal operation of a ship such as those resulting from the purification of fuel or lubricating oil for main or auxiliary machinery, separated waste oil from oil filtering equipment, waste oil collected in drip trays, and waste hydraulic and lubricating oils.

2.1.8 Oil residue (sludge) tank

Oil residue (sludge) tank means a tank which holds oil residue (sludge), and from which sludge may be disposed directly through the standard discharge connection or any other approved means of disposal.

2.1.9 Oily bilge water

Oily bilge water means water which may be contaminated by oil resulting from things such as leakage or maintenance work in machinery spaces. Any liquid entering the bilge system including bilge wells, bilge piping, tank top or bilge holding tanks is considered oily bilge water.

2.1.10 Oily bilge water holding tank

Oily bilge water holding tank means a tank collecting oily bilge water prior to its discharge, transfer or disposal.

2.1.11 Oily wastes

Oily wastes means oil residues (sludge) and oily bilge water.

2.1.12 Advanced Wastewater Treatment (AWT)

AWT means any treatment of wastewater that goes beyond the secondary or biological water treatment stage and includes the removal of nutrients such as phosphorus and nitrogen and a high percentage of suspended solids.

2.1.13 No discharge condition

No discharge condition means a condition without discharge of hazardous wastes, treated and untreated wastewater, oily wastes or garbage into the sea and without incineration carried out.

Note 1: Where the **AWT** notation is assigned to the ship, the discharge of treated sewage and treated grey water is allowed under the no discharge condition..

Note 2: In the "No discharge condition", no effluents from exhaust gas cleaning systems may be discharged into the sea.

2.2 Definitions related to air pollution

2.2.1 Emission

Emission means any release of substances, subject to control by Annex VI of MARPOL 73/78, from ships into the atmosphere or sea.

2.2.2 Global warming potential (GWP)

GWP means the climatic warming potential of a greenhouse gas relative to that of carbon dioxide (CO_2), calculated in terms of the 100-year warming potential of one kilogram of a greenhouse gas relative to one kilogram of CO_2.

2.2.3 Ozone depleting substances

Ozone-depleting substances means controlled substances defined in paragraph (4) of article 1 of the Montreal Protocol on Substances that Deplete the Ozone Layer, 1987, listed in Annexes A, B, C or E to the said protocol in force at the time of application of Annex VI of MARPOL 73/78.

Ozone-depleting substances that may be found on board the ship include, but are not limited to:

- Halon 1211 Bromochlorodifluoromethane
- Halon 1301 Bromotrifluoromethane
- Halon 2402 1,2-Dibromo-1,1,2,2-tetrafluoroethane (also known as Halon 114B2)
- CFC-11 Trichlorofluoromethane
- CFC-12 Dichlorodifluoromethane
- CFC-113 Trichloro-1,2,2-trifluoroethane
- CFC-114 1,2-Dichloro-1,1,2,2-tetrafluoroethane
- CFC-115 Chloropentafluoroethane.

2.2.4 NOx technical code

NOx Technical Code means the Revised Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines adopted at MEPC 58 on 10 October 2008 with IMO Resolution MEPC.177(58) as amended by IMO Resolution MEPC.317(74).

2.2.5 Permanently sealed equipment

Permanently sealed equipment are equipment where there is no refrigerant charging connections or potentially removable components containing ozone-depleting substances.

2.2.6 Emission control area

Emission control area means an area where the adoption of special mandatory measures for emissions from ships is required to prevent, reduce and control air pollution from NOx or SOx and particulate matter or all three types of emissions and their attendant adverse impacts on human health and the environment. Emission control areas include those listed in, or designated under, regulations 13 and 14 of Annex VI of MARPOL 73/78.

2.2.7 Shipboard incineration

Shipboard incineration means the incineration of wastes or other matter on board a ship, if such wastes or other matter were generated during normal operation of that ship.

2.2.8 Shipboard incinerator

Shipboard incinerator means a shipboard facility designed for the primary purpose of incineration.

2.3 Abbreviations

2.3.1 ECA

ECA means emission control area.

2.3.2 EGC

EGC means exhaust gas cleaning.

2.3.3 OWS

OWS means oily water separator.

Section 2 Design Requirements for the Notations CLEANSHIP and CLEANSHIP SUPER

1 General

1.1 Application

1.1.1 The requirements of this Section apply to ships assigned the additional class notations **CLEANSHIP** and **CLEANSHIP SUPER**.

1.1.2 Ships assigned the additional class notation **CLEANSHIP** are to comply with the provisions of Article [2].
Ships assigned the additional class notation **CLEANSHIP SUPER** are to comply with the provisions of Articles [2] and [3].

1.1.3 It is a prerequisite for the assignment of **CLEANSHIP** or **CLEANSHIP SUPER** that the ship complies with the following regulations:

- adopted Annexes of the MARPOL 73/78 Convention
- International Convention on the control of harmful anti-fouling systems, 2001.

Note 1: Additional requirements may be imposed by the ship Naval Authorities and/or by the State or Port Administration in the jurisdiction of which the ship is intended to operate.

1.1.4 Initial survey Tests

After installation on board, the equipment and systems relevant to the requirements of the present Chapter are to be tested in the presence of the Surveyor under operating conditions. The control, monitoring and alarm systems are also to be tested in the presence of the Surveyor or their functioning is to be simulated according to a procedure agreed with the Society.

1.1.5 Periodical tests and measurements to be done by the shipowner are given in Article [4].

1.2 Documents to be submitted

1.2.1 Certificates

The certificates to be submitted for the additional class notations **CLEANSHIP** and **CLEANSHIP SUPER** are listed in Tab 1.

1.2.2 Operational procedures

The operational procedures to be submitted for the additional class notation **CLEANSHIP** are listed in Tab 2

1.2.3 Plans and documents

The plans and documents to be submitted for the additional class notations **CLEANSHIP** and **CLEANSHIP SUPER** are listed in Tab 3.

Table 1 : Required certificates

Notations	Certificate	Applicable Rules and Regulations
CLEANSHIP **CLEANSHIP SUPER**	IOPP certificate **(1)**	Annex I of MARPOL 73/78, Appendix II
	Type approval certificate of: • 15 ppm bilge separator • 15 ppm bilge alarm	IMO Resolution MEPC.107(49) as amended by MEPC.285(70): • Part 1 of the Annex • Part 2 of the Annex
	ISPP certificate **(1)**	Annex IV of MARPOL 73/78, Appendix
	Type approval certificate of the sewage system	IMO Resolution MEPC.227(64) as amended by MEPC.284(70)
	Type approval certificate of the incinerator **(2)**	• IMO Resolution MEPC.244(66) as amended by IMO Resolution MEPC.368(79) • Annex VI of MARPOL 73/78, Appendix IV
	IAPP certificate **(1)**	• Annex VI of MARPOL 73/78, Appendix I • IMO Resolution MEPC.194(61)
	EIAPP certificates of diesel engines **(3)(4)**	NOx Technical Code 2008, Appendix I
	• SOx emission compliance certificate • Certificate of unit approval for exhaust gas cleaning system **(5)**	IMO Resolution MEPC.340(77), Appendix I
	IAFS certificate or Declaration on Anti-fouling system	International Convention on the control of Harmful and Anti-fouling systems, 2001, Annex 4, Appendices 1and 2

(1) Only where required by MARPOL 73/78 Convention, according to the ship's gross tonnage
(2) Shipboard incinerator is not required. However, when fitted on board, it is to be type-approved
(3) Only where required by Annex VI of MARPOL 73/78 Convention, according to the engine power and intended use
(4) The EIAPP certificate may include a NOx-reducing device as a component of the engine. See NOx Technical Code 2008, regulation 2.2.5
(5) Where such an equivalent arrangement is provided in pursuance of Annex VI of MARPOL 73/78 Convention, regulation 4

Table 2 : Required operational procedures

Operational procedure	Applicable Rules and Regulations
Shipboard oil pollution emergency plan	IMO Resolution MEPC.54(32) as amended by MEPC.86(44)
Procedure to prepare and maintain an oil record book **(1)**	Annex I of MARPOL 73/78, Appendix III
Procedure to maintain, operate and troubleshoot bilge water treatment systems	IMO Circular MEPC.1/Circ.677
Bunkering procedure	–
Measures to prevent oil pollution	–
Sewage and grey water management plan and discharge control plan **(1)**	IMO Resolution MEPC.157(55)
Garbage management plan including procedures to prepare and maintain a garbage record book and hazardous waste procedures **(1)**	• IMO Resolution MEPC.220(63) • IMO Circular MEPC/Circ.317 • Annex V of MARPOL 73/78, Appendix • IMO Resolution MEPC.92(45)
Operating procedure to be followed to minimise the risk and the consequences of ozone-depleting refrigerant leakage, under normal and emergency conditions, including: • checking of the piping tightness • recharge • detection of leakage • maintenance and repair **(2)**	–

(1) Only where required by MARPOL 73/78 Convention, according to the ship's gross tonnage.
(2) Only where ozone-depleting substances are used on board.

Operational procedure	Applicable Rules and Regulations
Procedure to prepare and maintain the ozone-depleting substances record book	–
NOx emission control plan	–
Fuel oil quality management plan	• Annex VI of MARPOL 73/78, Regulation 18 and Appendix VI • IMO Resolution MEPC.182(59)
Where an exhaust gas cleaning (EGC) system is used: • SOx emission compliance plan • Onboard monitoring manual • Procedure to prepare and maintain the EGC record book	IMO Resolution MEPC.340(77)
Biofouling management plan	IMO Resolution MEPC.378(80)
(1) Only where required by MARPOL 73/78 Convention, according to the ship's gross tonnage. **(2)** Only where ozone-depleting substances are used on board.	

Table 3 : Required plans and documents

Documents	A/I **(1)**
General:	
• general arrangement plan with indication of the waste collection and conveying circuits, storage means and treatment installations intended for the prevention of pollution by oil, sewage, grey waters, garbage and hazardous packaged substances	I
• capacity plan	I
• program for a waste source reduction, minimization and recycling	A
Prevention of pollution by oil:	
• diagram of the oil residue (sludge) system,	I
• diagram of the independent clean drain system, where provided	I
• diagram of the oily bilge system (pumping, treatment, discharge)	I
• details of the bilge water holding tank	A
• calculation of the bilge water holding tank capacity	A
Prevention of pollution by wastewater:	
• diagram of the grey water system (collection, treatment, discharge)	I
• diagram of the sewage system (collection, treatment, discharge)	I
• details of the sewage holding tank and grey water holding tank	A
• calculation of the sewage holding tank and grey water holding tank capacity	A
• description of the sewage treatment plant or comminuting/disinfecting system	I
Prevention of pollution by garbage:	
• general information on the equipment intended for collecting, storing, processing and disposing of garbage (except where type-approved)	I
• calculation of the necessary storing, processing and disposing capacities	A
• diagram of control and monitoring systems for garbage handling equipment	A
Prevention of pollution by oil spillage and leakage:	
• diagram of the fuel oil and lubricating oil overflow systems	A
• diagram of the fuel oil and lubricating oil filling, transfer and venting systems	I
• arrangement of the fuel oil and lubricating oil spillage containment systems	A
• diagram of the control and monitoring system for fuel oil filling, transfer and overflow systems	I
• diagram of the stern tube lubricating oil system	A
Prevention of oil pollution in case of collision or stranding:	
(1) A = to be submitted for approval ; I = to be submitted for information **Note 1:** Diagrams are to include information about monitoring and recording of parameters.	

Documents	A/I **(1)**
• arrangement of the fuel oil tanks, lubricating oil tanks and sludge tanks with indication of the volume and of the distance between the tank and the ship base line/ship shell side	I
Prevention of pollution by anti-fouling systems: • specification of antifouling paint	A
Prevention of pollution by refrigerants and fire-fighting media: • arrangement of retention facilities including material specifications, structural drawings, welding details and procedures, as applicable	A
• means to isolate portions of the plant so as to avoid release of medium	A
(1) A = to be submitted for approval ; I = to be submitted for information **Note 1:** Diagrams are to include information about monitoring and recording of parameters.	

2 Design requirements for the additional class notation CLEANSHIP

2.1 Waste management

2.1.1 Separation of waste streams

Design arrangements and procedures for collecting, sorting, treating, storing and discharging solid and liquid waste and harmful substances are to be such that the discharge or discharge prohibition criteria laid down in annexes I, IV and V of MARPOL 73/ 78 Convention can be fulfilled.

2.2 Oily wastes

2.2.1 Compliance with MARPOL 73/78

Ships assigned the additional class notation **CLEANSHIP** are to comply with the following requirements of MARPOL 73/78 Convention, Annex I, and with the relevant unified interpretations:

- Reg. 12 for arrangement and capacity of oil residues (sludge) tanks
- Reg. 13 for standard discharge connection
- Reg. 14 for oil filtering equipment
- Reg. 15 for oil discharge criteria
- Reg. 17 for oil record book (machinery space operations).

2.2.2 Bilge water holding tank

All machinery space bilges and spaces containing hydraulic equipment are to be drained into a bilge water holding tank before separation and oil filtration or discharge ashore. This bilge holding tank is to be separate and independent from the sludge tanks.

Sea or freshwater drains not contaminated by oil may be discharged overboard.

The bilge water holding tank is to be arranged so as to facilitate the separation of any oil (or oil emulsions resulting from the use of bilge cleaning agents) from the bilge water and the removal of accumulated sediments.

The shore discharge piping system from the bilge water holding tank is to be terminated by the standard discharge connection specified in MARPOL 73/78 Convention, Annex I, Reg. 13.

2.2.3 Oil water separating equipment

The following equipment is to be provided on board and is to comply with IMO Resolution MEPC.107(49) as amended by IMO Resolution MEPC.285(70):

- 15 ppm bilge separator
- 15 ppm bilge alarm
- automatic stopping device.

The bilge separator, bilge alarm and automatic stopping device are to be type approved and individually certified by the Society. Existing type approval or certification (e.g. Directive 2014/90/EU) may be considered by the Society.

The capacity of the bilge separator is to take into account the route of the vessel, the volume of the bilge water holding tanks and the separating technology.

The 15 ppm bilge separator and the 15 ppm bilge alarm are to be installed in accordance with the provisions of IMO Resolution MEPC.107(49), paragraph 6, as amended by IMO Resolution MEPC.285(70).

2.2.4 Oil residue (sludge) tanks

The minimum capacity of the oil residue (sludge) tank is to be calculated according to the criteria specified in MARPOL Annex I, Unified Interpretation 16.

The arrangement of the oil residue (sludge) tank is to comply with MARPOL Annex I, reg. 12 and is to:

- be provided with a designated pump that is capable of taking suction from oil residue (sludge) tank(s) for disposal of oil residue (sludge). Oil residue (sludge) may be disposed of directly from the oil residue (sludge) tanks through the standard discharge connection referred to in MARPOL 73/78, Annex I, Reg. 13, or any other approved means of disposal
- have no discharge connections to the bilge system, oily bilge water holding tank(s), tank top or oily water separators unless for arrangement authorized in MARPOL Annex I, reg. 12.3 (see also IACS recommendation 121)
- be designed and constructed so as to facilitate their cleaning and the discharge of residues to reception facilities.

2.2.5 Overboard discharges from the bilge pumping system

The overboard discharge valve of any bilge overboard discharge line, unless passing through the 15 ppm bilge separator, is to be kept shut and provided with lead-sealing arrangements.

Note 1: Lead-sealing arrangements is not to be understood as a requirement for the valves to be blanked or physically locked. Emergency bilge discharge, and other overboard discharge valves of similar nature, must be available for use at all times in case of an emergency (SOLAS regulation II-1/21). Valve sealing may be accomplished through use of a breakable seal, electronic tracking, or similar method.

2.2.6 Segregation of oil and water ballast

No ballast water is to be carried in any fuel oil or lubricating oil tank.

2.2.7 Discharge records

Provisions are to be made to record the following parameters related to the oily water discharge:

- date and time of the discharge
- ship location
- quantity and oil content of oily water discharged.

2.2.8 Operational procedures

Operational procedures covering oil pollution prevention are to cover the following topics:

- procedure to maintain, operate and trouble shoot bilge water treatment systems
- procedure to prepare and maintain an oil record book.

2.3 Wastewaters

2.3.1 Compliance with MARPOL 73/78

Ships assigned the additional class notation **CLEANSHIP** are to comply with the following requirements of MARPOL 73/78 Convention, Annex IV, as amended:

- Reg. 9 for sewage systems
- Reg. 10 for standard discharge connection
- Reg. 11 for discharge criteria.

Note 1: Discharge of grey water is not regulated by MARPOL 73/78 Convention.

Note 2: Attention is drawn to the fact that some national regulations prohibit the discharge of sewage (treated or untreated) and grey water while in port or within other designated areas.

2.3.2 Design and arrangement of the sewage system

The ship is to be equipped with one of the following sewage systems:

- a sewage treatment plant, or
- a sewage comminuting and disinfecting system fitted with facilities for temporary storage of sewage when the ship is less than 3 nautical miles from the nearest land, or
- a holding tank of the capacity to the satisfaction of the Society (see [2.3.3]).

In case a sewage treatment plant is installed on board without sewage holding tank, justifications are to be provided for operation in areas, such as port, where outboard discharge of sewage and treated sewage is not permitted.

2.3.3 Holding tanks

The holding tanks are to be efficiently protected against corrosion and fitted with a level indicator and a high level alarm.

The holding tank capacity is to be justified in regards on the ship's intended usage, the maximum number of people on board and the sewage treatment systems installed on board. The wastewater quantities to be considered are to be derived from the experience gained on similar types of ships operated in similar conditions. Where no data is available, the figures listed in Tab 4 are to be used.

The sewage discharge pipes connection to reception facilities are to be fitted with standard discharge connection in accordance with MARPOL, Annex IV, Reg. 10.

Sewage, including drainage from medical premises, is to be collected separately from grey water, except if a common treatment installation is installed on board.

Note 1: This does not preclude the mixing of effluents after treatment (e.g. treated sewage mixed with grey water).

Note 2: When sea water is mixed with wastewater (e.g. for the purpose of washing the holding tanks), the discharge requirements for the wastewater apply to the resulting mixture.

Note 3: When categories of wastewater having different discharge requirements are mixed together, the most stringent requirements apply to the resulting mixture.

2.3.4 Sewage treatment plants and piping

Sewage treatment plants are to be of a type approved and individually certified by the Society. Existing type approval or certification (e.g. Directive 2014/90/EU) may be considered by the Society. Sewage treatment plants are to comply with the provisions of IMO Resolution MEPC.227(64) as amended by MEPC.284(70).

Provisions are to be made in the design for easy access points for the purpose of obtaining representative influent and effluent samples.

The capacity of the sewage treatment plant is to be enough to accommodate the maximum number of people on board. The wastewater quantities to be considered are to be derived from the experience gained on similar types of ships operated in similar conditions. Where no data are available, the figures listed in Tab 4 are to be used.

Table 4 : Wastewaters generation quantities

N°	Type of waste	Unit	Quantities for			
			Frigates, Aircraft carriers or Amphibious vessels	Corvettes	Patrol vessels or Landing craft	Auxiliary vessels
1	Black water	litres/person/day	12 for a vacuum system 100 for a conventional flushing system			
2	Grey water (excluding laundry and galley)	litres/person/day	160	150	50	100
3	Laundry	litres/person/day	80	20	20	40
4	Galley	litres/person/day	90	30	30	60
5	Total grey water (2+3+4)	litres/person/day	330	200	100	200

2.3.5 Discharge records

Provisions are to be made to record the following parameters related to the sewage discharge:

- date and time of discharge
- position of the ship (latitude and longitude)
- quantity of sewage discharged.

2.3.6 Operational procedures

The sewage and grey water management plan and discharge control plan are to cover the following topics:

- sewage and grey water installation and maintenance
- procedures and arrangement to obtain representative influent and effluent samples
- discharge control plan and procedure following requirements and prescription of MARPOL Annex IV, reg.11, MEPC.157(55) “Recommendation on Standards for the Rate of Discharge of Untreated Sewage from Ships”, and, as relevant, other regulations such as MEPC.264(68), part II-A, Chapter 4.

2.4 Garbage and hazardous wastes

2.4.1 Compliance with MARPOL 73/78

Ships assigned the additional class notation **CLEANSHIP** are to comply with the requirements of MARPOL 73/78, Annex V:

- Reg. 3, 4, 5 and 6 for disposal into the sea criteria
- Reg. 9 for placards, garbage management plans and garbage record-keeping.

2.4.2 Storage and disposal

Except otherwise stated in this Article, storage arrangements are to be provided for all kinds of liquid and solid wastes, with a capacity corresponding to one day operation of the ship.

Note 1: Although disposal into the sea and onboard incineration are possible in the conditions specified in MARPOL 73/78 Convention, storage and subsequent discharge to port reception facilities is to be given first priority. Attention is drawn to the specific requirements imposed by certain flag Authorities and/or State or Port Administration, which may restrict or prohibit waste discharge and/or incineration in the waters under their jurisdiction.

2.4.3 Handling of hazardous waste

Hazardous wastes are to be collected and stored in separate leakproof containers prior to disposal ashore. The storage capacity is to be sufficient for the average production of 30 days. The contents of all containers are to be clearly marked.

Note 1: Waste fluids associated with photo processing, including X-ray development, may be treated to remove silver for recycling. The effluent from the recovery unit may be led to the grey water provided it contains less than 5 parts per million (ppm). The residues from the recovery unit are to be landed ashore for disposal or recycling.

2.4.4 Collection of garbage

Garbage bins are to be placed at suitable places and within a suitable distance in accommodation spaces and open decks.

Hazardous wastes, plastics and food contaminated wastes are to be collected separately from other wastes.

2.4.5 Storage of garbage

The ship is to have sufficient capacity to store all kinds of garbage produced during one day, taking into account the daily waste generation figures given in Tab 5 and the values of density given in Tab 6.

If incineration is permitted in the areas where the ship is intended to operate, the needed capacity for wastes other than glass and tins may be reduced by 40%, without being less than the needed volume corresponding to one day.

Table 5 : Garbage generation quantities

No.	Type of waste	Unit	Quantities for			
			Frigates, Aircraft carriers, Amphibious vessels	Corvettes	Patrol vessels, Landing craft	Auxiliary vessels
1	Plastics	kg/person/day	0,1	0,1	0,1	0,1
2	Paper and cardboard	kg/person/day	1,0	1,0	1,0	1,0
3	Glass and tins	kg/person/day	1,0	1,0	1,0	1,0
4	Food wastes	kg/person/day	0,7	0,7	0,7	0,7
5	Total garbage (1+2+3+4)	kg/person/day	2,8	2,8	2,8	2,8

Table 6 : Waste density

Type of waste	Density (kg/m^3)	
	compacted waste	uncompacted waste
Glass, tin	1600	160
Paper, cardboard, plastic	410	40
Food wastes	–	300

2.4.6 Food wastes

Arrangements are to be made to store food wastes prior to discharge to port reception facilities or, where permitted, disposal into the sea.

The onboard storage capacity is to be sufficient for one day food waste production, taking into account the figures given in Tab 5 and the values of density given in Tab 6.

Where food waste disposal into the sea is permitted, precautions are to be taken to ensure that plastics contaminated by food wastes, like plastic food wrappers, are not discharged to sea with other food wastes.

2.4.7 Incinerators

Where fitted, incinerators are to be type-approved by the Society and individually certified by the Society. Existing type approval or certification (e.g. Directive 2014/90/EU) may be considered by the Society. Incinerators are to be designed and constructed according to the requirements of:

- IMO Resolution MEPC.244(66), as amended by IMO Resolution MEPC.368(79)
- MARPOL Annex VI, Appendix IV.

Proper hazardous waste management procedures including segregating hazardous wastes are to be instituted on board each ship to assure hazardous wastes are not introduced into the incinerator. In particular, batteries are to be removed from any waste that will be incinerated on board.

2.4.8 Discharge records

Provisions are to be made to record the following parameters related to the garbage discharge:

- date and time of discharge
- ship location (latitude and longitude) or location of ashore discharge facilities
- estimated amounts discharged for each category, including incinerator ash (in cubic meters).

2.4.9 Garbage management plan

Procedures for collection, sorting, processing and disposal of garbage are to be available in the garbage management plan required by MARPOL 73/78, Annex V, Reg. 9.

The garbage management plan is to follow MEPC.220(63) “2012 Guidelines for the development of garbage management Plan”. Restrictions to the discharge of garbage into the sea are to be clearly indicated and in accordance to MARPOL Annex V (see also MEPC.295(71) 2017 Guidelines for the implementation of MARPOL Annex V, Table 1).

The garbage management plan is to include procedures in order to make sure that the following hazardous wastes are not discharged at sea nor mixed with other waste streams:

- photo processing waste (including X-ray development fluid waste)
- dry cleaning waste, containing in particular tetrachloro-ethylene or perchloroethylene (PERC)
- printing materials, like inks, except soy based, non chlorinated hydrocarbon based ink products
- laser printer toner cartridges
- unused and outdated pharmaceuticals
- fluorescent / mercury vapour bulbs
- batteries
- used cleaners, solvents, paints and thinners
- products containing metals such as lead, chromium, copper, cadmium and mercury.

2.5 Hull anti-fouling systems

2.5.1 Compliance with IMO AFS Convention

Ships assigned the additional class notation **CLEANSHIP** are to comply with the relevant requirements of IMO Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001, requiring the complete prohibition of organotin compounds which act as biocides and of cybutryne in anti-fouling systems.

2.5.2 Type-approval of anti-fouling systems

Anti-fouling paints are to be of a type approved by the Society, on the basis of the following criteria:

- the product is to be free of organotin tributyltin (TBT)
- small quantities of organotin compounds acting as a chemical catalyst are allowed provided their concentration does not exceed 2500 mg total tin per kg of dry paint
- average values of cybutryne are not to exceed 200 mg of cybutryne per kg of dry paint.

2.5.3 Biofouling record book

Provisions are to be made to record the biofouling management activities in accordance with the biofouling management plan, including:

- details of repair and maintenance to the anti-fouling system and the marine growth prevention system
- in-water inspection and inspection report
- cleaning operation and cleaning reports
- details of operations outside the ship's normal operating profile
- details of relevant performance monitoring parameters used to determine inspection intervals
- contingency action.

2.5.4 Biofouling management plan

The biofouling management plan is to be in accordance with IMO resolution MEPC.378(80).

2.6 Prevention of pollution by oil spillage and leakage

2.6.1 Compliance with MARPOL 73/78

Ships assigned the additional class notation **CLEANSHIP** are to comply with MARPOL 73/78 Convention, Annex I, regulation 12A (Oil fuel tank protection).

2.6.2 Overflow systems

All fuel and lubricating oil tanks the capacity of which exceeds 10 m^3 are to be fitted with an overflow system and a high level alarm or a flow alarm in the overflow system. The alarm signal is to be given where the person in charge of the bunkering or transfer operation will normally be located.

Note 1: The overflow system is to comply with the provisions of Pt C, Ch 1, Sec 10, [9.3].

2.6.3 Containment systems

On the weather and superstructure decks, each fuel or lubricating oil tank vent, overflow and fill pipe connection and each other area where oil spillage may occur is to be fitted with a fixed deck container or enclosed deck area with a capacity of:

- 80 litres if the gross tonnage of the ship is between 300 and 1600
- 160 litres if the gross tonnage of the ship is greater than 1600.

The deck container or area is to be fitted with a closed drainage system.

Note 1: As an alternative arrangement to the closed drainage system, the Society may accept manual draining by gravity or by means of a portable pump, in conjunction with a suitable procedure covering the draining operation, the disposal of the drained oil and the cleaning of the container.

2.6.4 Stern tube leakage

Sealing glands are to be provided with an oil leak prevention air seal or the stern tube oil is to be of a non-toxic and biodegradable quality approved in accordance with recognized standards.

The oil tanks are to be fitted with a level sensor giving an alarm in case of low level. Arrangements are to be made to record the level of those tanks.

All oil filling or topping up operations are to be recorded.

2.6.5 Oily condensates from venting pipes

Vent pipes from engine crankcases are to be led to a venting box provided with a draining pipe connected to a suitable oily drain tank.

2.6.6 Operational procedures

The onboard operational procedure is to cover:

- measures to prevent oil pollution
- oil leakage and spillage management and disposal, and cleaning of the deck container.

2.7 Refrigeration systems

2.7.1 Compliance with MARPOL 73/78

Ships assigned the additional class notation **CLEANSHIP** are to comply with MARPOL 73/78 Convention, Annex VI, regulation 12 (Ozone Depleting Substances).

2.7.2 Application

The following requirements apply to the ship refrigeration and air conditioning (AC) permanent installations with an initial charge of more than 3kg or more than 5 tonnes of CO2 equivalent of refrigerant.

They do not apply to permanently sealed equipment as defined in Ch 7, Sec 1, [2.2.5].

2.7.3 Acceptable refrigerants

The use of ozone-depleting substances, including hydrochlorofluorocarbons (HCFCs), as refrigerant is prohibited.

2.7.4 Retention facilities

Refrigeration systems are to be fitted with retention facilities having the capability to retain the volume of refrigerant contained in the largest individual refrigeration unit, should the necessity arise to empty any one unit. The retention facilities may be either:

- fully independent from the refrigeration system, i.e. separate tanks, or
- opart of the refrigeration system, i.e. redundant condensors: In this case, the combined capacity of the condensors is to be sufficient to store the total volume of refrigerant in the system considering that any one condensor is unavailable e.g. for repair or maintenance reasons.

The retention facilities may be tanks for liquid media and/or bottles for gaseous media. If only tanks for liquid are used as retention facilities, one or more compressors having the combined capacity to discharge completely the medium from the system into the tanks are to be installed.

2.7.5 Prevention of leakage

The following measures are to be taken in order to avoid deliberate emissions of ozone depleting substances:

- refrigeration systems are to be designed in such a way as to minimise the risk of medium release in the case of maintenance, repair or servicing.
- arrangements are to be made to isolate those sections which are to be serviced by a system of valves and by-passes, in such a way as not to stop the operation of the plant, while in service, preventing the risk of release of the medium outside of the plant.
- means are to be provided to avoid the possibility of leak to the atmosphere of the refrigerants or its vapours in any case of failure of the plant.
- a warning instruction plate stating that deliberate emissions of halogenated substances are prohibited is to be displayed in the vicinity of the vessels and of the releasing devices.

These requirements do not apply to spaces containing only pipes.

2.7.6 Leak detection

Leak detectors are to be installed in spaces where the medium might leak in order to provide continuous leak monitoring.

Provisions for the following verifications are to be made in the onboard operational procedure:

- checking by the shipowner of the leakage detection system at least once every 12 months to ensure its proper functioning
- additional checking of the refrigerants by trained people for leakage at a frequency shown in Tab 7, depending on the initial charge of the system in tonnes of CO2 equivalent, and corrective actions and repairs in case of leakage detection.

Table 7 : Leak checks minimum frequency

Charge of fluorinated greenhouse gas - Teq.C02	Leak checks maximum interval – no leakage detection installed	Leak checks maximum interval – with leakage detection installed
From 5 up to 50	6 months	2 months
Above 50 up to 500	3 months	6 months
Above 500	1 months	3 months

2.7.7 Alarm

Any detection of medium leak is to activate an audible and visible alarm in a normally manned location. The alarm is to be activated when the concentration of refrigerant reaches a value agreed with the Society on a case by case basis, considering LEL and limit of toxicity of the refrigerant used in the system.

2.7.8 Records

Provisions are to be made to record:

- recharge, full or partial, of equipment containing ozone depleting substances
- repair or maintenance of equipment containing ozone depleting substances, including:
  - checks for leakage
  - checks of leakage detection system.
- discharge of ozone depleting substances to the atmosphere and leakage
- discharge of ozone depleting substances to land-based reception facilities
- supply of ozone depleting substances to the ship, storage location and quantities.

2.7.9 Operational procedures

The refrigerant management plan is to include:

- maintenance procedure
- leakage checking frequency and procedure
- leakage detection system checking frequency and procedure
- list and quantity of all refrigerant on board
- qualification and training of personnel

2.8 Fire-fighting systems

2.8.1 Compliance with MARPOL 73/78

Ships assigned the additional class notation **CLEANSHIP** are to comply with MARPOL 73/78 Convention, Annex VI, regulation 12 (Ozone Depleting Substances).

2.8.2 Acceptable fire-fighting media

The use of halon and halocarbons media in the fixed and portable fire fighting equipment is prohibited.

2.8.3 Design requirements for fire-fighting systems

Provisions are to be made for the safe containment and disposal of fire-fighting media in case of spillage during maintenance or repair.

2.9 Emission of nitrogen oxides (NOx)

2.9.1 Compliance with MARPOL 73/78

Diesel engines fitted to ships assigned the additional class notation **CLEANSHIP** are to comply with the requirements of:

- MARPOL 73/78, Annex VI, Reg. 13
- NOx Technical Code (2008), as amended.

2.9.2 Application

The following requirements apply to all diesel engines, independently of the service, with a rated power of more than 130 kW, installed on the ship, with the exceptions of:

- emergency diesel engines, diesel engines installed in lifeboats and any other diesel engines intended to be used solely in an emergency situation, independently of their rated power
- engines which are subject to alternative measures for limiting NOx emission, under special consideration of the Society.

Note 1: NOx emissions from gas only engines, gas turbines, boilers and incinerators are not subject to these requirements.

2.9.3 NOx certification of engines

Prior to installation on board the ship, engines are to be NOx-certified in accordance with the relevant provisions of the NOx Technical Code for the intended application. A valid EIAPP certificate (or statement of compliance) is normally to be issued by the Society.

2.9.4 NOx reduction methods

Where NOx reduction methods (such as water injection, fuel oil emulsification, charge air humidification, exhaust gas after-treatment) are used, they are to be approved by the Society and taken into account in the EIAPP certificate of the engine.

The measurement of NOx emission levels, where required for the control of the reduction process (e.g. to adjust the injection rate of the reduction agent for SCR systems), is to be carried out by means of type-approved analysers.

2.9.5 Urea solutions used for SCR systems

The SCR storage tank containing the chemical treatment fluids is to be protected from excessively high or low temperatures applicable to the particular concentration of the solution. Depending on the operational area of the ship, this may necessitate the fitting of heating and/or cooling systems. The physical conditions recommended by applicable recognized standards (such as ISO 18611-3) are to be taken into account to ensure that the contents of the aqueous urea tank are maintained to avoid any impairment of the urea solution during storage.

2.10 Emission of sulphur oxides (SOx)

2.10.1 Compliance with MARPOL 73/78

Ships assigned the additional class notation **CLEANSHIP** are to comply with the relevant requirements of MARPOL 73/78 Convention, Annex VI and related Guidelines:

- Reg. 13 for Sulphur Oxides (SOx) and Particulate Matter
- Reg. 18 and Appendices V and VI for fuel oil quality
- IMO Resolution MEPC.182(59) for the sampling of fuel oil.

2.10.2 Use of low sulphur fuel oils

Where several types of fuel are used in pursuance of [2.10.1], arrangements are to be made to allow the complete flushing of the high sulphur fuel supply system before entering the emission control area (ECA).

Arrangements are to be made to record the following parameters:

- volume of fuel oil in each tank
- date, time and position of the ship when the fuel change-over operation is completed or started (respectively when entering the ECA or leaving the ECA).

2.10.3 Use of exhaust gas cleaning systems

a) Exhaust gas cleaning (EGC) systems, which may be accepted as an arrangement equivalent to the use of low sulphur fuel oils in pursuance of MARPOL 73/78 Convention, Annex VI, Regulation 4.1, are to be approved in accordance with IMO Resolution MEPC.340(77): 2021 Guidelines for exhaust gas cleaning systems.

b) EGC systems are to be fitted with data measuring, recording and processing devices in accordance with IMO Resolution MEPC.340(77).

c) The discharge washwater is to satisfy the criteria given in IMO Resolution MEPC.340(77).

d) A holding tank having a capacity sufficient to store washwater treatment residues generated by the EGC unit during 30 days operation of the ship is to be provided on board.

Note 1: Washwater treatment residues generated by the EGC are then delivered ashore to adequate reception facilities in order not to be discharged to the sea or incinerated on board.

Note 2: These requirements are also applicable to the residues holding tanks of EGC unit integrated in an EGR.

The EGC system's storage tank containing the chemical treatment fluids is to be protected from excessively high or low temperatures applicable to the particular concentration chemical treatment fluids. Depending on the operational area of the ship, this may necessitate the fitting of heating and/or cooling systems.

3 Additional design requirements for the additional class notation CLEANSHIP SUPER

3.1 Waste minimization and recycling program

3.1.1 Direct waste minimization and recycling programs involving significant reduction of the waste amounts mentioned in Tab 1 are to be implemented. Such programs are to cover the influence of measures such as:

- use of technical water (e.g. air conditioning condensate) where possible
- use of water recovery systems (e.g. filtering and reuse of laundry water - last rinse use for first wash)
- reclamation and reuse of properly treated and filtered wastewaters as technical water (e.g. in toilet flushing, laundry, open deck washing). Effluents from water treatment plants may be reused or recycled only if they comply with a recognised quality standard for potable water.
- active water conservation (e.g. use of reduced flow shower heads, vacuum systems for toilets, laundry equipment that utilizes less water)
- use of reusable packaging and bulk packaging
- replacement of plastic packaging by containers built in other material
- minimization of the amount of oily bilge water and processing of the oily bilge water and oil residue (sludge) in accordance with the Integrated Bilge Water Treatment System (IBTS) concept (see IMO Circular MEPC.1/Circ.642 as amended).

3.1.2 In addition to the procedures required in [2.4.9], the garbage management plan is to include the procedures for garbage source reduction, minimization and recycling.

3.2 Oily wastes

3.2.1 The bilge water holding tank is to have a capacity that provides to the ship the flexibility of operation in ports, coastal waters and special areas, without the need to discharge de-oiled water overboard. The minimum capacity of the bilge water holding tank is not to be less than the value calculated from Tab 8 (in m3). Lower capacity is to be justified.

Table 8 : Minimum capacity of the bilge water holding tank according to main engine rating

Main engine rating (kW)**(1)**	Capacity (m^3)
up to 1000	4
above 1000 up to 20000	P / 250
above 20000	40 + P / 500
(1) For diesel-electric propulsions, the main engine rating is to be substituted with the aggregate power of the electric power motors. where P: Main engine rating in kW	

3.3 Wastewaters

3.3.1 Design and arrangement of the sewage and grey water systems

The ship is to be fitted with a sewage system and a grey water system designed and arranged as follows:

- an approved sewage treatment plant or sewage comminuting and disinfecting system is to be provided
- a tank is to be provided for the storage of untreated or treated sewage with a capacity complying with [3.3.2]
- a tank is to be provided for the storage of grey waters with a capacity complying with [3.3.2]
- grey waters from galleys are to be collected separately from other grey waters and led through a grease trap prior to additional treatment, storage or discharge.

Note 1: Treated sewage and grey water holding tanks may be combined together.

Note 2: Plastic garbage is to be separated from sewage and/or grey waters before entering the treatment unit.

3.3.2 Holding tanks

Holding tanks for sewage and grey water are to have a capacity sufficient for 24 hours operation of the ship, having regard to the maximum number of persons on board, the daily production of wastewater given in Tab 1and other relevant factors.

3.3.3 Sewage sludge

Arrangement are to be made for sludge from sewage treatment to be collected and stored then discharged ashore or, where permitted, incinerated on board.

Where provided, incineration devices are to completely burn the sludge to a dry and inert ash and not to discharge fly ash, malodors or toxic substances.

The capacity of the sewage sludge tanks is to be calculated taking into consideration:

- the maximum period of voyage between ports where sludge can be discharged ashore, or
- the incinerator capacity and whether incineration is permitted in the areas where the ship is intended to operate.

In the absence of precise data, a figure of 30 days is to be used.

Arrangements are to be made to dispose of ashes from sludge incineration ashore.

3.3.4 Discharge records

Provisions are to be made to record the following parameters related to the sewage and grey water discharges:

- date and time of discharge
- position of the ship (latitude and longitude)
- quantity of sewage and/or grey water discharged
- quantity of sludge incinerated or discharged ashore.

3.4 Food wastes

3.4.1 Arrangements are to be made to store food wastes and wastes contaminated with food in high integrity sealed packaging and refrigerated to 5°C.

3.5 Prevention of pollution by oil spillage and leakage

3.5.1 Containment systems

A seven-barrel spill kit containing the following is to be available on board, ready to be used during bunkering operation:

- sorbents sufficient to absorb seven barrels of oil
- non-sparking hand scoops, shovels and buckets
- portable containers suitable for holding seven barrels of recovered solid waste and seven barrels of recovered liquid waste
- a minimum of 60 litres of a deck cleaning agent
- appropriate protective clothing to protect personnel from inhalation hazards, eye exposure and skin contact
- non-sparking portable pumps with appropriate hoses.

3.5.2 Oil detection in cooling water circuits

Hydrocarbon detectors are to be provided in sea water and fresh water cooling systems comprising fuel oil or lubricating oil heat exchangers in order to detect any contamination of the water.

3.6 Protection against oil pollution in the event of collision or grounding

3.6.1 All fuel oil and lubricating oil tanks are to be located in protected locations in accordance with the provisions of NR467, Pt C, Ch 1, Sec 10, [11.5.3].

Note 1: This requirement does not apply to engine lubricating oil drain tanks.

3.7 Prevention of air pollution

3.7.1 All refrigerants used on board are to have:

- a Global Warming Potential (GWP) not exceeding 2000
- an Ozone Depleting Potential (ODP) equal to zero.

3.8 Monitoring and recording systems

3.8.1 On-board emission measurement and monitoring equipment

Ships assigned the additional class notation **CLEANSHIP SUPER** are to provided with a type-approved measurement, monitoring and recording equipment, for:

- NOx emissions, in compliance with MO Resolution MEPC.103(49)
- SO2 and CO2 emissions, in compliance with IMO Resolution MEPC.340(77).

Note 1: The correspondence between the SO2/CO2 ratio and the sulphur content of the fuel oil is detailed in IMO Resolution MEPC.340(77) Table 1 and Appendix II.

3.8.2 Remote transmission of the parameters related to waste discharge and air emissions

All the waste discharge and air emission parameters required to be monitored and recorded as per the requirements of Articles [2] and [3] are to be transmitted on a regular basis (e.g. every day) via a satellite communication system to a shipowner facility ashore. Such information is to be made available to the Surveyor of the Society upon request.

4 Onboard tests and measurements

4.1 Application

4.1.1 This Article contains additional requirements applying to the additional class notations **CLEANSHIP** and **CLEANSHIP SUPER**.

4.2 Periodical tests and measurements done by the Shipowner

4.2.1 Purpose

The following tests and measurements, done under the responsibility of the Shipowner, are intended to demonstrate the effective implementation of the waste management procedures and the constant level over time kept by the quality of the effluents discharged at sea.

4.2.2 Initial period tests

During the first year of commercial operation, the Shipowner is to proceed with the following measurements and analyses:

- collection of actual shipboard data's concerning the volume of wastes generation, using the waste streams as defined in Tab 4 and Tab 5
- effluent analyses from the sewage treatment plant, on a yearly basis.

4.2.3 Periodical tests after first year of service

The effluents and wastes usually discharged to sea are to be periodically sampled and analysed by a qualified laboratory. The frequency of these tests in a five-year period is specified in Tab 9.

Tab 10 lists the number of occurrences where the pollutant maximum concentration may exceed the limit concentration specified in Tab 11 for the effluent standard for analyses of waters, without exceeding the reject value.

Test results of the measurements are to be recorded in the wastewater and garbage logbooks and made available to the Surveyor during the periodical surveys.

Table 9 : Frequency of analyses of waste streams after the first year of service

Waste stream	Number of analyses in a 5-year period
Sewage treatment plant effluent analyses	2
Machinery bilge water oil content analyses	2

Table 10 : Permissible number of analyses exceeding limit values

Number of analyses in a 5-year period	Maximum number of analyses above limit
2 - 5	0
20	2

Table 11 : Analyses standard for waters

Water to be tested	Pollutant	Limit concentration	Reject value
Effluent of oil filtering equipment	Oil	15 ppm	–
Effluent of sewage treatment plant	Thermotolerant coliforms (TC)	100 TC / 100 ml	–
	Total suspended solids (TSS)	35 mg/l	–
	5-day biochemical oxygen demand (BOD_5) **(1)**	25 mg/l	–
	Chemical oxygen demand (COD)	125 mg/l	–

(1) BOD_5 is the amount, in milligrams per litre, of oxygen used in the biochemical oxidation of organic matter in five days at 20°C.

Section 3 Design Requirements for the Pollution Prevention Notations other than CLEANSHIP and CLEANSHIP SUPER

1 General

1.1 Application

1.1.1 The requirements of this Section apply to ships having one of the additional class notations for pollution prevention listed in Ch 7, Sec 1 other than **CLEANSHIP** and **CLEANSHIP SUPER**.

1.2 Documents to be submitted

1.2.1 Certificates

The certificates to be submitted for the aforementioned additional class notations are listed in Tab 1

1.2.2 Operational procedures

The operational procedures to be submitted for the aforementioned additional class notations are listed in Tab 2.

1.2.3 Plans and documents

The plans and documents to be submitted for the aforementioned additional class notations are listed in Tab 3.

Table 1 : Required certificates

Notations	Certificate	Applicable Rules and Regulations
AWT	Type approval of the AWT plant	[2]
BWE	Certificate not required	–
BWT	Type approval certificate of the ballast water management system (BWMS)	IMO BWMS Code, IMO Resolution MEPC.169(57)
GREEN PASSPORT	See NR528	
GWT	Type approval certificate of the grey water treatment plant	[5]
NDO-x days	Certificate not required	–
NOX-x%	EIAPP certificates of diesel engines **(1)**	[7]
OPS()	See NR467 Pt F, Ch 14, sec 4	
OWS-x ppm	Type approval certificate of the oily water separator with indication of "x ppm" performance	[8]
SOX-x%	Type approval certificate of the exhaust gas cleaning system **(2)**	[9]

(1) The EIAPP certificate may include a NOx-reducing device as a component of the engine. See NOx Technical Code 2008, regulation 2.2.5.
(2) Where such an equivalent arrangement is provided in pursuance of Annex VI of MARPOL 73/78 Convention, regulation 4.

Table 2 : Required operational procedures

Notations	Operational procedure	Applicable Rules and Regulations
AWT	Wastewater management plan and discharge control plan	–
BWE	Ballast water management plan, with procedures to prepare and maintain a Ballast Water Record Book	IMO Resolution MEPC.127(53) as amended by MEPC.306(73)
BWT	As above for **BWE** notation	• IMO Resolution MEPC.127(53) as amended by MEPC.306(73) • IMO Circular BWM.2/Circ.20
	Detailed procedures and information for safe application of active substances	
GREEN PASSPORT	See NR528	
GWT	Grey water management plan and discharge control plan	–

Notations	Operational procedure	Applicable Rules and Regulations
NDO-x days	Management and storage plan for liquid effluents and solid waste in case of no-discharge operation	–
NOX-x%	NOx emissions control plan	–
OPS()	See NR467 Pt F, Ch 14, sec 4	
OWS-x ppm	Performance monitoring plan for the oily water separator	–
SOX-x%	SOx emissions control plan	–

Table 3 : Required plans and documents

Notation	Documents	A/I **(1)**
AWT	• diagram of the grey water system (collection, treatment, discharge)	I
	• diagram of the sewage system (collection, treatment, discharge)	I
	• details of the sewage holding tank and grey water holding tank	A
	• calculation of the sewage holding tank and grey water holding tank capacity	A
	• description of the Advanced Wastewater Treatment (AWT) plant and relevant operating principles	I
BWE	See IMO Resolution MEPC.149(55) and Pt C, Ch 1, Sec 10	A / I **(2)**
BWT	See Regulation 5.7 of IMO Resolution MEPC.279(70) or Regulation 5.1 of IMO Resolution MEPC.174(58), as appropriate, and NR467, Pt C, Ch 1, Sec 13	A / I **(2)**
GREEN PASSPORT	See Rule Note NR528	A / I **(2)**
GWT	• diagram of the grey water system (collection, treatment, discharge)	I
	• details of the grey water holding tank	A
	• calculation of the grey water holding tank capacity	A
	• description of the grey water treatment plant and relevant operating principles	I
NDO-x days	Calculation of the storage capacity for solid wastes and liquid effluents	A
NOX-x%	• calculation of the weighted average NOx emission level of the ship	A
	• calculation of the weighted average IMO Tier II NOx emission limit of the ship	A
OPS()	NR467 Pt F, Ch 14, sec 4	A / I **(2)**
OWS-x ppm	Description of the OWS plant and relevant operating principles	I
SOX-x%	Where low sulphur fuel oils are used:	
	• diagram of the fuel oil supply systems	I
	• change-over procedure	I
	Where an exhaust gas cleaning system is fitted:	
	• washwater diagram	A
	• description of the system and relevant operating principles	I

(1) A = to be submitted for approval; I = to be submitted for information
(2) For approval or information, in accordance with the relevant Rules or Rule Note
Note 1: Diagrams are to include information about monitoring and recording of parameters.

2 Additional class notation AWT

2.1 Scope

2.1.1 The additional class notation **AWT** applies to ships fitted with an advanced wastewater treatment (AWT) plant, capable of treating both sewage and grey waters with an effluent quality complying with the relevant provisions of [2.3].

Note 1: Effluents from the AWT plant may be reused or recycled only if they comply with a recognised quality standard for potable water.

2.1.2 Periodical tests and measurements to be done by the Shipowner are given in Article [2.4].

2.2 Definitions and abbreviations

2.2.1 Thermotolerant coliforms (TC)

Thermotolerant coliforms means the group of coliform bacteria which produce gas from lactose in 48 hours at 44.5°C.

Note 1: Thermotolerant coliforms are sometimes referred to as “fecal coliforms”. The term thermotolerant coliforms is now accepted as more appropriate, since not all of these organisms are of faecal origin.

2.2.2 TRC

TRC means Total Residual Chlorine. TRC is the chlorine remaining in wastewater at the end of a specified contact period as combined or free chlorine.

2.2.3 TSS

TSS is the pollutant parameter total suspended solids.

2.3 Design of the AWT plant

2.3.1 Required capacity

The capacity of the AWT plant is to be sufficient for the maximum number of persons onboard, taking into account the sewage and grey water quantities given in Ch 7, Sec 2, Tab 4.

2.3.2 Type tests

Advanced Wastewater Treatment plants are to be of a type approved in accordance with IMO Resolution MEPC.227(64), including paragraph 4.2, as amended by MEPC.284(70).

2.4 Periodical tests and measurements

2.4.1 Purpose

The following tests and measurements, done under the responsibility of the shipowner, are intended to demonstrate the effective implementation of the waste management procedures and the constant level over time kept by the quality of the effluents discharged at sea.

2.4.2 Initial period tests

During the first year of commercial operation, the Shipowner is to perform quarterly effluent measurements and analyses for the Advanced Wastewater Treatment plant installed onboard.

2.4.3 Periodical tests after first year of service

The frequency of the effluents and wastes usually discharged to the sea and to be tested in a five-year term period, and the number of occurrences where the pollutant maximum concentration may exceed the limit concentration, without exceeding the reject value are specified in Tab 4. Limit concentration and reject values are specified in Tab 5.

Test results of the measurements are to be recorded in the wastewater logbooks and made available to the surveyor during the periodical surveys.

Table 4 : Frequency of analyses of waste streams after the first year of service

Waste stream	Number of analyses in a 5-year period	Maximum number of analyses above limit
Effluent analyses for Advanced Wastewater Treatment	20	2

Table 5 : Analyses standard for waters

Water to be tested	Pollutant	Limit concentration	Reject value
Effluent of AWT unit	5-day biochemical oxygen demand (BOD_5)**(1)**	25 mg/l	60 mg/l
	Chemical oxygen demand (COD)	125 mg/l	–
	Total residual chlorine	7,5 µg/l	100 µg/l
	Thermotolerant coliforms (TC)	14 TC/100 ml	40 TC/100 ml
	Total suspended solids (TSS)	30 mg/l	150 mg/l
	Total nitrogen	20 mg/l	–
	Total phosphorus	1,0 mg/l	–
(1) BOD_5 is the amount, in milligrams per litre, of oxygen used in the biochemical oxidation of organic matter in five days at 20°C.			

3 Additional class notation BWE

3.1 Scope

3.1.1 The additional class notation **BWE** applies to ships intended for ballast water exchange at sea and whose design is in compliance with the technical provisions of BWM convention (2004), Regulation D-1, and with the requirements of this Article.

3.2 Design requirements

3.2.1 Design of the pumping and piping systems

The pumping and piping systems involved in the ballast water exchange are to comply with the provisions of Pt C, Ch 1, Sec 10, [7].

3.2.2 Sediment handling

Arrangements are to be made for:

- monitoring the sediment build up
- cleaning the tanks and removing the sediments
- disposing the sediments to reception facilities.

3.2.3 Ballast water exchange operations

The Ballast water management plan is to describe ballast water exchange procedure in accordance with IMO Resolution MEPC.288(71).

3.2.4 Discharge records

Provisions are to be made to get and record the following parameters related to the ballast water discharge:

- date and time of discharge
- ship location (latitude and longitude)
- amounts of water exchanged
- amount of sediments disposed to reception facilities.

4 Additional class notation BWT

4.1 Scope

4.1.1 The additional class notation **BWT** applies to ships complying with the International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 and to the relevant Guidelines, and fitted with an approved ballast water treatment system.

4.2 Design and installation requirements

4.2.1 General

The ballast water treatment system is to be designed and installed in accordance with the provisions of NR467, Pt C, Ch 1, Sec 13.

4.2.2 Ballast water treatment records

Provisions are to be made to get and record the following parameters related to the ballast water discharge/treatment:

- date and time of ballast water discharge and intake (when the treatment is performed at the intake stage)
- ship location (latitude and longitude)
- date, time, duration and conditions of treatment (at intake or discharge stage, or during voyage)
- amounts of water treated.

5 Additional class notation GWT

5.1 Scope

5.1.1 The additional class notation **GWT** applies to ships fitted with a grey water treatment system, the effluents from which have a quality complying with [5.2].

Note 1: Effluents from the grey water treatment plant may be reused or recycled only if they comply with a recognised quality standard for potable water.

5.2 Design of the grey water treatment plant

5.2.1 Required capacity

The capacity of the grey water treatment plant is to be sufficient for the maximum number of persons onboard, taking into account the daily production of grey water given in Ch 7, Sec 2, Tab 4.

5.2.2 Effluent quality

The grey water treatment plant is to be so designed that the minimum level of effluent quality complies with the limits given in IMO Resolution MEPC.227(64), including paragraph 4.2, as amended by MEPC.284(70).

5.2.3 Type tests

Grey water treatment plants are to be type-approved in accordance with IMO Resolution MEPC.227(64) as amended by MEPC.284(70).

6 Additional class notation NDO-x days

6.1 Scope

6.1.1 The additional class notation **NDO-x days** applies to ships having sufficient onboard storage capacity for solid waste and liquid effluents, allowing the fully loaded ship to operate under the no discharge condition as defined in Ch 7, Sec 1, [2.1.13], during x consecutive days (no discharge period).

6.2 Design requirements

6.2.1 The storage capacity for each of the following solid and liquid wastes is to be sufficient to allow the no discharge operation of the ship during x days:

- plastics
- paper and cardboard
- glass and tins
- food waste
- sewage (see Note 1)
- grey water (see Note 1)
- sewage sludges (where applicable)
- bilge water
- oil residues (sludge)
- hazardous wastes
- washwater treatment residues from EGC units (where applicable).

Note 1: Storage capacity is not required for treated sewage and treated grey water when the notation **AWT** is assigned to the ship.

6.2.2 Except otherwise stated, the storage capacities are to be based on:

- the maximum number of persons onboard
- the daily production of solid waste and liquid effluents given in Ch 7, Sec 2, Tab 4 and Ch 7, Sec 2, Tab 5.

6.2.3 Unless otherwise justified, the minimum capacity required for the bilge water holding tank is not to be less than x times the capacity given in Ch 7, Sec 2, Tab 8.

7 Additional class notation NOX-x%

7.1 Scope

7.1.1 The additional class notation **NOX-x%** applies to ships fitted with diesel engines having a weighted average NOx emission level not exceeding x% of the weighted average IMO Tier II limit.

The NOx performance index x is to be ≤ 90.

7.2 Design requirements

7.2.1 General

The diesel engines to be considered are those referred to in Ch 7, Sec 2, [2.9.2].

NOx reducing devices may be considered if they are covered by the EIAPP certificate of the engine.

7.2.2 Calculation of the weighted average NOx emission level of the ship

The weighted average NOx emission level of the ship [NOx]ship in g/kWh, is to be calculated as follows:

$$[NOx]_{ship} = \frac{\sum_{i=1}^{n} [NOx]_i \cdot P_i}{\sum_{i=1}^{n} P_i}$$

where:

n : Total number of engines installed on the ship

[NOx]i : NOx emission level of each individual engine as per EIAPP certificate (in g/kWh)

P_i : Rated power of each engine (in kW).

7.2.3 Calculation of the weighted average IMO Tier II NOx emission limit of the ship

The weighted average IMO Tier II NOx emission limit of the ship [IMO]ship, in g/kWh, is to be calculated as follows:

$$[IMO]_{ship} = \frac{\sum_{i=1}^{n} [IMO]_i \cdot P_i}{\sum_{i=1}^{n} P_i}$$

where:

n, P_i : As defined in [7.2.2]

[IMO]i : Applicable IMO Tier II NOx emission limit of each individual engine as per MARPOL 73/78, Annex VI, Reg. 13.4 (in g/kWh).

7.2.4 Calculation of the NOx performance index x

The NOx performance index x is to be calculated as follows:

$$x = \frac{[NOx]_{ship}}{[IMO]_{ship}}$$

where:

[NOx]ship :Weighted average NOx emissions for the ship (in g/kWh), as calculated in [7.2.2]

[IMO]ship: Weighted average IMO Tier II NOx emission limit for the ship (in g/kWh), as calculated in [7.2.3].

8 Additional class notation OWS-x ppm

8.1 Scope

8.1.1 The additional class notation **OWS-x ppm** applies to ships fitted with an oily water separator (OWS) capable of producing effluents having a hydrocarbon content not exceeding x ppm.

The OWS performance index x is to be ≤ 10.

Note 1: ppm means parts of oil per million parts of water by volume.

8.2 Design requirements

8.2.1 The OWS is to be type approved and individually certified by the Society. For this purpose:

- the OWS is to comply with the provisions of IMO Resolution MEPC.107(49) as amended by IMO Resolution MEPC.285(70), for an effluent quality of x ppm, and
- the bilge alarm and the automatic stopping device are to be efficient for the x ppm limit.

Existing type approval or certification (e.g. Directive 2014/90/EU) may be considered by the Society.

9 Additional class notation SOX-x%

9.1 Scope

9.1.1 The additional class notation **SOX-x%** applies to ships using fuel oils complying with the following criteria:

- the sulphur content of fuel oils used in emission control areas (ECAs) is not to exceed x% of the IMO limit given in MARPOL 73/78, Annex VI, regulation 14.4
- the sulphur content of fuel oils used in other areas is not to exceed x% of the IMO limit given in MARPOL 73/78, Annex VI, regulation 14.1

The SOx performance index x is to be ≤ 90.

Alternative arrangements may be accepted if the resulting SOx emission reduction is deemed equivalent to that corresponding to the use of fuel oils with reduced sulphur content.

9.2 Design requirements

9.2.1 Use of fuel oils with reduced sulphur content

Where fuel oils with reduced sulphur content are used, the requirements in Ch 7, Sec 2, [2.10] are to be complied with.

9.2.2 Use of exhaust gas cleaning systems as alternative arrangement

Where exhaust gas cleaning systems are used, they are to be approved in accordance with IMO Resolution MEPC.340(77), for a SOx emission performance corresponding to the use of a fuel oil having a sulphur content of x% of the IMO sulphur limit applicable to ECAs.

Provisions of Ch 7, Sec 2, [2.10.3] and Ch 7, Sec 2, [3.8.1] for data measuring and recording are to be complied with.

Part E
Additional Class Notations

CHAPTER 8
CBRN

Section 1 General

1 General

1.1 Scope

1.1.1 The present chapter details requirements for the protection of personnel onboard naval ships intended for operation in atmospheres contaminated by chemical, biological, radiological or nuclear hazardous material (CBRN) for rescue or damage control purposes.

It is to be noted however that these requirements do not cover:

- Operation in outside explosive atmosphere.
- Resistance to the mechanical effects of explosions leading to CBRN contamination, except the resistance of the collective protection system to air blast for ships to be assigned the additional class notation **CBRN-AIR BLAST RESISTANCE**. In particular, this chapter does not cover the resistance of structure to air blast and thermal effects of nuclear or non-nuclear explosions.
- CBRN contamination coming from inside the ship.

In addition, it is to be noted that protection against, and especially detection of, biological contamination is covered only insofar as it is specified by the Naval Authority in the CBRN operation specification, considering the effective limits of the technical solutions available for this purpose.

1.2 Application

1.2.1 The additional class notation **CBRN** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.11.1] to ships equipped in order to permit safe operation in CBRN conditions and complying with the requirements of the present chapter. The requirements of the additional class notation **CRBN** are applicable when considering a contamination coming only from outside of the ship. Other cases will be considered on a case-by-case basis.

1.2.2 The additional class notation CBRN may be completed by **-AIR BLAST RESISTANCE** for ships having a collective protection system designed to withstand air blast according to the requirements of Ch 8, Sec 3, [3].

1.3 Documentation to be submitted

1.3.1 The documentation to be submitted is listed in Tab 1.

Table 1 : Documentation to be submitted

No.	I/A **(1)**	Documentation
1	I	CBRN operation manual
2	I	Citadel and shelter general arrangement
3	A	Citadel, airlock and cleansing station ventilation drawing, system details and sizing calculation
4	A	Arrangement of the CBRN protection plant, including, for ships to be assigned the additional class notation **CBRN-AIR BLAST RESISTANCE**, details of the air blast protective device
5	A	Details of ventilation opening controls and monitoring
6	I	Engine room general arrangement
7	A	Details of engine air supply and engine casing
8	A	Details of door arrangement, control and monitoring
9	A	CBRN detection system drawing and details
10	A	Electrical equipment certificates for environmental protection, in line with Ch 8, Sec 4, [2.1.1]
11	A	Diagram of the scupper and sanitary discharge system
12	A	Pre-wetting and washdown system drawing, system details and sizing calculation
13	I	Calculation of required airflows, pressure and CO_2 levels during the collective protection ventilation test, unless this test is carried out with the specified maximum number of people on board, see [2.3.3]
(1) A: To be submitted for approval ; I : To be submitted for information		

No.	I/A **(1)**	Documentation
14	A	Fire control plan showing: • citadel, sub-citadels and/or shelter • storage location of personal protective equipment • CBRN detection system • pre-wetting and washdown system and associated control valves
15	I	Procedures in case of fire during CBRN operation
(1) A: To be submitted for approval ; I : To be submitted for information		

1.3.2 CBRN operation specification

It is the responsibility of the Naval Authority to detail the range of CBRN threats to be covered in order to enable efficient protection. The following information is to be clearly stated as a basis for design and in-service follow-up:

- CBRN agents to be considered (especially the list of chemical or bacteriological agents to be considered).
- Particulars of the required detection system(s), especially whether biological detection is required and whether a portable detection system is acceptable.
- Nature of operations to be carried out in the polluted area (mere crossing of the polluted area or e.g. personnel rescue, pollution control / cleanup, coordination etc.). Specific spaces and systems related to these operations that need to be operable in CBRN mode are to be listed.
- Maximum duration for such operations.
- Number of persons on board during operation (intervention personnel and rescued people).
- Number of persons that may be engaged simultaneously in a CBRN operation requiring wearing PPE, referred to in Ch 8, Sec 3, [5.2.2].
- List of spaces required to be included in the citadel, as well as functionalities that may be available to a limited extent under CBRN mode (e.g. cooking and food supply) as referred to in Section 2 [1.1.2]
- List of spaces allowed to be non-sheltered, if any, as referred to in Section 2 [3.1.1]
- Specific overpressure values and associated tolerances, especially if different from the reference values mentioned in this Chapter
- Particulate filters collection efficiency
- Required arrangement of cleansing stations
- Philosophy for decontamination operations, required capacity of the pre-wetting and washdown system if different from that given in Ch 8, Sec 3, [4.1.2] and whether specific systems or weapons need to be cleaned manually rather than covered by the pre-wetting and washdown system.

1.3.3 The CBRN operation manual is to include:

- The CBRN operation specification.
- A plan showing the citadel, space for rescued people, shelter, airlock and cleansing station arrangement.
- A plan showing all liquid and gastight closing appliances that need to be closed prior to CBRN operation, together with a description of the closing appliances including the position indicator, if any, showing that the device is well configurated for the CBRN operation.
- A detailed description of the detection system required in Ch 8, Sec 3, [1] with relevant drawings, operating instructions and alarm codes for the CBRN detection system.
- A detailed description and drawings of the citadel ventilation system. Parts of the system to be used solely for CBRN operation are to be outlined.
- Detailed procedure for switching to CBRN mode including:
  - closure of all openings
  - modifications of the ventilation system if relevant
  - CBRN filter activation.
- Measures to be taken in case of alarm related to the CBRN system (e.g. loss of overpressure).
- Measures to be taken in case of fire during CBRN operation.
- Measures to be taken for the replacement of the filters and for their disposal after contamination.

1.4 Definitions and abbreviations

1.4.1 CBRN

Chemical, Biological, Radiological and Nuclear.

1.4.2 CBRN mode

Activation of the CBRN mode provides a contamination-free area in the whole citadel.

CBRN mode needs to be defined for the following systems:

- monitoring, control and alarm systems, including management of the airlocks and cleansing station
- CBRN detection system
- collective protection system
- pre-wetting and washdown system.

1.4.3 CBRN operation

Ship operation in an environment where CBRN hazard is expected. During CBRN operation, the citadel and the collective protection system are switched to CBRN mode.

1.4.4 Citadel

Space or group of spaces surrounded by liquid and gastight boundaries and protected by overpressure and filtrated air ventilation system, in view of allowing personnel inside the citadel to keep their operational capability without wearing PPE in case of external CBRN contamination.

1.4.5 Collective protection system

The collective protection system is the ventilation system that provides a contamination-free environment in the citadel by:

- keeping the citadel at an overpressure with respect to the outside atmosphere and,
- providing clean air inside the citadel.

1.4.6 Shelter

Space or group of spaces that can be made liquid and gastight.

1.4.7 Sub-citadel

Subdivision of the citadel that can be made gastight with respect to another sub-citadel.

2 Construction testing and inspection

2.1 General

2.1.1 This Article details acceptance tests to be carried out during ship commissioning. They may be carried out at yard or during sea trials.

2.2 Closure test

2.2.1 Remote closing of all openings in the citadel and shelter boundaries is to be tested, including doors, valves and ventilation openings.

2.3 Collective protection ventilation test

2.3.1 The collective protection ventilation system is to be tested upon building completion in order to demonstrate that the required overpressure can be maintained, and that the CO_2 level remains acceptable.

2.3.2 Once the pressure has been stabilized in the citadel, the overpressure is to be maintained for a duration corresponding to the minimum between:

- 1h and
- the maximum duration for CBRN operation according to the CBRN operation specification.

2.3.3 The required airflows, pressure and CO_2 levels may be assessed by the Shipyard based on calculation according to a standard acceptable to the Society. Alternatively, the test may be carried out with a number of people inside the citadel equal to the maximum number of people on board during CBRN operation according to the CBRN operation specification and it is to be checked that CO_2 levels in all spaces, including machinery spaces, remain acceptable during the whole test. In this case, the test duration may need to be adapted to ensure stabilization of the CO_2 level.

2.3.4 The citadel overpressure is to remain within the required range during the whole test. This includes:

- differential pressure between the citadel and the outside atmosphere
- differential pressure between the citadel, cleansing station, airlocks and outside atmosphere
- differential pressure between machinery spaces included in the citadel and the rest of the citadel, if applicable
- differential pressure between engine enclosure and machinery spaces, if applicable.

2.3.5 A functioning test of the airlocks and cleansing stations is to be carried out with the collective protection ventilation system working.

2.4 CBRN detection test

2.4.1 A functioning test of the CBRN detection system is to be carried out. However, no actual contamination is to be used for the purpose of this test.

2.4.2 Each line is to be tested from the level of the detector, with means defined by the system supplier, in order to verify that detector activation will trigger the required alarms.

2.5 Pre-wetting and washdown test

2.5.1 A functioning test of each section of the pre-wetting and washdown system is to be carried out.

2.5.2 It is to be checked that all external surfaces are actually covered by a film of water while the system is activated.

2.5.3 Proper drainage of the water is to be checked, i.e. that there is no water accumulation on deck.

2.5.4 Remote operation of each section valve is to be tested.

Section 2 Ship Arrangement

1 Citadel

1.1 Space to be included in the citadel

1.1.1 The ship is to be provided with a citadel covering all enclosed spaces that may need to be accessed during CBRN operation, as defined in the CBRN operation specification. The ventilation of the citadel is to comply with the requirements of Ch 8, Sec 3, [2].

1.1.2 The citadel is to include at least all accommodation spaces and normally manned control stations, galleys and pantries, any space dedicated to the storage of food, and normally manned machinery spaces.

However, where specified in the CBRN operation specification, some of these spaces may be excluded from the citadel provided that the required functionalities are available in the citadel.

Note 1: See Article [6] for machinery space arrangement, especially engine room.

1.2 Sub-citadels

1.2.1 On ships having two or more safety zones, the citadel is to be divided into at least two sub-citadels, the boundaries of which are to coincide as much as possible with those of safety zones.

Ships assigned the service notation **corvette** may however be provided with a single citadel not subdivided into sub-citadels if agreed with the Naval Authority.

1.2.2 The boundaries of the sub-citadels are to comply with [1.4].

1.2.3 Access between two separate sub-citadels is to be possible only through gastight, self-closing doors, or watertight doors. An indication of the position of such doors is to be provided at the damage control station.

1.3 Spaces where explosive atmosphere may occur

1.3.1 If spaces where an explosive atmosphere may occur, such as ro-ro or vehicle spaces, paint store, battery room, ammunition space or other spaces as relevant, need to be covered by the collective protection system, they are to be provided with a dedicated, gastight exhaust duct and their ventilation system is to comply with the requirements of Ch 8, Sec 3, [2.2].

1.3.2 If an aircraft hangar is included in the citadel, interlocks and visual and audible alarms are to be provided to prevent any opening of the hangar door while the personnel working inside the hangar are unprotected.

1.4 Boundaries of the citadel

1.4.1 All boundaries of the citadel are to be liquid and gastight.

1.4.2 All openings in the citadel boundaries, except air supply ducts directly led to engines enclosed in a gastight enclosure, are to be able to be made liquid and gastight:

- either automatically, or
- by manual operation, both locally and from the damage control station.

Doors and hatches that are required to be closed during CBRN operation need not be remotely controlled from the damage control station.

1.4.3 Doors in citadel boundaries are generally to open towards the inside of the citadel or the compartment with the highest overpressure level. Where this is not feasible due to e.g. means of escape design constraints, means of latching are to be provided so as to ensure that the door in closed position will withstand the pressure differential expected when the citadel is pressurized.

1.4.4 Hold-back hooks not subject to release from the damage control station are prohibited on doors in citadel boundaries.

1.4.5 Indication is to be provided in the damage control station as to whether each opening in the citadel boundary is open or closed.

1.4.6 Windows in the citadel boundary are to be liquid and gastight and of the non-opening type.

1.4.7 Cable and duct penetrations in citadel boundaries are to be reduced to a minimum and, where needed, are to be designed so as to reconstitute the tightness of the penetrated deck or bulkhead.

1.5 Means of access to the citadel

1.5.1 As a minimum, access to and egress from the citadel is to be possible through:

- One cleansing station complying with the requirements of Article [5] for access and/or egress during CBRN operation.
- One airlock - which may be combined with the airlock included in the cleansing station - complying with the requirements of Article [4] for egress during CBRN operations.

1.5.2 Ships assigned the service notation **aircraft carrier** are to be provided with at least two cleansing stations, preferably distributed over two separate sub-citadels. Ships assigned the service notation **corvette**, **military offshore patrol vessel**, **frigate**, **auxiliary naval vessel** or **amphibious vessel** may be provided with only one cleansing station.

1.5.3 As far as practicable, the airlocks and cleansing stations provided for access to and egress from the citadel are also to be the main and secondary escape routes from the citadel.

2 Space for rescued people

2.1 Accommodation for rescued people

2.1.1 When rescuing of people is part of the ship's CBRN operation specification, a dedicated space is to be available as accommodation for rescued people. This space is to be included in the citadel and provided with suitable ventilation, lighting and sanitary facilities.

2.1.2 Spaces for rescued people may be used for other purposes when the ship is not in CBRN rescuing operation. However, rescued people are not to be accommodated in the radio room, the wheelhouse or the damage control station and main access passageways, which are to be kept clear.

2.2 Means of escape

2.2.1 Spaces for rescued people are to be provided with means of escape in line with the applicable requirements of Pt C, Ch 4, Sec 8.

3 Shelter

3.1 Sheltered spaces

3.1.1 In general, any enclosed space that is not part of the citadel - i.e. not protected by overpressure ventilation - is to be capable of being made liquid and gastight for the whole duration of the CBRN operation. On a case-by-case basis and if agreed by the Naval Authority, unprotected and non-tight enclosed spaces may however be accepted.

3.1.2 Sheltered spaces are to be provided with means of cooling in order to maintain a temperature allowing proper functioning of the equipment installed therein during CBRN operation.

3.2 Openings in shelter boundary

3.2.1 Any opening in the boundaries of such shelters is to comply with the requirements of [1.4] for openings in the boundaries of the citadel.

4 Airlock

4.1 Arrangement

4.1.1 Airlocks are to have a simple shape in order to avoid air pockets and are to be provided with two doors not less than 1 m apart.

Airlocks intended for both access to, and egress from, the citadel are to be provided with 3 doors leading to:

- the citadel
- the other enclosures of the cleansing station, and
- the outside.

All three doors are to be not less than 1 m apart.

4.1.2 The ventilation of the airlocks is to comply with the requirements of Ch 8, Sec 3, [2.4].

4.1.3 Airlocks are to be enclosed by gastight boundaries and doors.

4.2 Doors

4.2.1 Airlock doors are to be self-closing doors or watertight doors. Doors leading to the open deck need not be self-closing doors.

4.2.2 Airlock doors are to be wide enough to allow the passage of personnel wearing Personal Protective Equipment (PPE).

4.2.3 Means are to be provided to ensure that only one door may be opened at a time during CBRN operation. An alarm is to be provided at the damage control station in case more than one of the doors is not fully closed.

4.3 Purging

4.3.1 The doors of airlocks are to be provided with interlocks ensuring that the door leading to the interior of the citadel will remain closed for a duration sufficient to ensure airlock purging after the door leading to the open deck or to the cleansing station has been opened.

4.3.2 Airlock purging is to consist of at least 5 air changes. Attention is to be paid to possible air pockets and toxic gases accumulation, considering actual airflow.

5 Cleansing station

5.1 Arrangement

5.1.1 A shower is to be arranged immediately outside the cleansing station for initial decontamination before entering the cleansing station.

5.1.2 Cleansing stations are to be so arranged as to allow total undressing of potentially contaminated personnel and undressing of Personal Protective Equipment (PPE), decontamination of personnel and containment and cleaning of contaminated PPE or clothing.

5.1.3 The cleansing station is to include four successive gastight enclosures complying with one of the following approaches:

a) 2-stage cleansing stations are to include:
   - One first stage enclosure
   - One central airlock complying with the provisions of Article [4]
   - One second stage enclosure, and
   - One final airlock complying with the provisions of Article [4] and giving access to the citadel.

b) 3-stage cleansing stations are to include:
   - 3 successive gastight enclosures, and
   - One final airlock complying with the provisions of Article [4] and giving access to the citadel.

Each enclosure and airlock listed in items a) and b) is to be gastight with respect to each other and they are to be maintained at an overpressure with respect to atmospheric pressure. The overpressure is to decrease gradually when going from the citadel towards the open deck. The ventilation of the airlocks and cleansing stations is to comply with the requirements of Ch 8, Sec 3, [2.4].

5.1.4 When rescuing people is part of the ship's CBRN operation specification or if specified by the Naval Authority:

- the enclosures of the cleansing station are to be sized to allow the entry and decontamination of personnel carrying a stretcher with a casualty and relevant medical equipment.
- access from the cleansing station to the ship hospital or medical area, if provided, is to be as direct as possible.

5.2 Doors and boundaries

5.2.1 Cleansing stations are to be enclosed by gastight boundaries and doors.

5.2.2 Cleansing station doors are to be self-closing doors without any fixing device.

5.2.3 Cleansing station doors, except the door leading to the open deck, are to be provided with viewing ports.

5.2.4 Means are to be provided to ensure that only one door can be opened at a time during CBRN operation. An alarm is to be provided at the damage control station in case more than one of the doors is not closed.

6 Machinery space arrangement

6.1 Allowable arrangements for engine room and internal combustion machinery spaces

6.1.1 The requirements of [6.1.2] to [6.1.4] are applicable to engine rooms and to all machinery spaces containing internal combustion machinery that is required to remain operational during CBRN operation. For ease of reading, such machinery spaces are called "engine room" in the following requirements.

6.1.2 Depending on the ship operating range and CBRN operation philosophy, the engine room may be:

- included in the citadel, i.e. ventilated with decontaminated air and maintained in overpressure with respect to the outside atmosphere, or
- sheltered, i.e. able to be closed liquid and gastight.

6.1.3 If the engine room is included in the citadel, the requirements of [6.2] are to be applied, together with all requirements applicable to spaces in the citadel.

6.1.4 If the engine room is sheltered:

- the ship is to be assigned the additional class notation **AUT-QAS** as defined in Pt A, Ch 1, Sec 2, [6.5.2] and Ch 4, Sec 1, and
- the requirements of [6.3] are to be applied.

6.2 Machinery space included in the citadel

6.2.1 Access from a machinery space included in the citadel to other spaces in the citadel and vice-versa is to be through a gastight door complying with the requirements of [1.4.3].

6.2.2 Internal combustion machinery required to remain operational during CBRN operation is to be enclosed in a gastight enclosure and provided with a dedicated air supply duct. Engines with gastight design may be accepted as an alternative to a gastight enclosure around the engine. Engine supply and exhaust air ducts are to be gastight and are to comply with the requirements of Pt C, Ch 1, Sec 10, [17].

6.2.3 The engine enclosure is to be maintained at a pressure below ambient pressure in the engine room. The differential pressure between the engine room and the enclosure is to be at least 50 Pa.

6.3 Sheltered machinery space

6.3.1 Sheltered machinery spaces are to comply with the provisions of Article [3].

6.3.2 In addition, access from a sheltered machinery space to the citadel is to be through an airlock complying with the requirements of Article [4].

6.3.3 Internal combustion machinery required to remain operational during CBRN operation is to be gastight or enclosed in a gastight enclosure and provided with a dedicated ducted air supply, in line with the requirements of [6.2.2].

6.4 Fire protection

6.4.1 Machinery spaces located outside of the citadel are to be provided with a fixed fire-extinguishing system complying with the relevant requirements of Pt C, Ch 4, Sec 14.

6.4.2 In case the engine is enclosed in a gastight enclosure, the enclosure is to be provided with a fixed fire detection and fire alarm system and with a fixed fire-extinguishing system suitable for category A machinery spaces and complying with the relevant requirements of Pt C, Ch 4, Sec 14.

6.5 Engine room cooling

6.5.1 A cooling system is to be provided in the engine room in order to keep the temperature at an acceptable level for personnel and to maintain safe equipment operation during CBRN operation.

7 Superstructure design

7.1 Precautions for decontamination

7.1.1 The shape of external decks and superstructures is to be such as to avoid local accumulation of water.

7.1.2 Surfaces that may be exposed to CBRN agents are to be made of easily decontaminable materials. This includes exposed interior surfaces in airlocks and cleansing stations and unprotected spaces, as well as external surfaces.

Alternatively, removable means of protection of interior surfaces of airlocks and cleansing stations may be provided for installation before CBRN operations, if specified by the Naval Authority in the CBRN operation specification.

7.2 Ventilation openings

7.2.1 The ventilation openings are to be arranged so as to prevent water ingress in the ventilating ducts when the pre-wetting and washdown system is in use.

8 Marking

8.1 Openings

8.1.1 All openings in the citadel and shelter boundaries are to be prominently marked. The marking is to indicate clearly (e.g. with a color code) in which situation the concerned opening may or may not be open.

8.2 Equipment

8.2.1 Equipment the setting of which needs to be modified locally for entering CBRN mode is to be prominently marked. The marking is to indicate clearly the relevant setting for each situation (CBRN operation or standard operation).

Section 3 CBRN Protection

1 Detection system

1.1 Detection

1.1.1 The ship is to be provided with a fixed CBRN detection system, consisting of detectors, cables, data treatment unit and control panel, adapted to the CBRN agents to be considered as per the CBRN operation specification.

A portable CBRN detection system may however be accepted when specified by the Naval Authority in the CBRN operation specification.

1.1.2 For fixed CBRN detection systems, detectors are to be provided as detailed in Tab 1.

Where portable CBRN detection system is provided, the number of portable detectors is to be in line with the requirements stated in the CBRN operation specification.

1.1.3 Detectors are to be of a type approved by the Society, complying with the requirements of Pt C, Ch 3.

Note 1: The performance of the detectors may be covered by military standards defined by the Naval Authority in addition to the type approval by the Society.

1.1.4 Radioactivity detectors are to remain accessible for maintenance purposes.

Table 1 : Minimum number and location of CBRN detectors

Hazard	Location				
	In the citadel	Filtering station **(1)**	Cleansing station **(2)**	Open air	Sea water below the waterline
Radioactivity	As a minimum, one detector per sub-citadel and one detector at the navigation bridge	1	1	2	1
Chemical agents				1 **(4) (5)**	
Biological agents **(3)**	To be agreed depending on concerned biological agent				

(1) The detector is to be located immediately downstream of the filters
(2) One detector per cleansing station is to be provided. The detector may be installed either in the cleansing station, or in the citadel close to the access to the cleansing station
(3) Biological agent detection is required only if and as specified by the Naval Authority in the CBRN operation specification
(4) Outside chemical detectors are to be located away from:
- ventilation and engine exhaust openings
- superstructures and physical obstacles

(5) Additional outside chemical detectors may be required by the Naval Authority depending on the ship type and configuration.

1.2 Alarm and monitoring

1.2.1 An audible and visual alarm is to be provided at the navigation bridge and at the damage control station in case CBRN contamination is detected. The alarms are to be distinct depending on the detected hazard. The location where contamination is detected is to be indicated.

In addition, an alarm is to be provided locally in case contamination values above thresholds are measured at any one detector.

1.2.2 For each hazard covered by the CBRN detection system, the detected agent or agent family and measured value at the location where contamination has been detected is to be displayed at the damage control station.

1.2.3 An alarm is to be provided throughout the citadel in case CBRN contamination is detected inside the citadel. The criterion for triggering an alarm in the whole citadel may be higher than that for triggering an alarm at the navigation bridge and damage control station, e.g. higher measured value, time delay or number of detectors impacted, to the satisfaction of the Society.

2 Ventilation and collective protection system

2.1 Citadel ventilation

2.1.1 The citadel, or each sub-citadel where provided, is to be provided with a dedicated ventilation system, which does not serve any other space not included in the citadel or sub-citadel. Arrangements may however be provided to interconnect the ventilation systems of two sub-citadels in degraded mode provided gastight means of segregation between the ventilation systems serving each sub-citadel are installed for use in normal CBRN configuration.

2.1.2 The citadel ventilation system is to be capable of maintaining an overpressure of at least 500 Pa relative to atmospheric pressure in all spaces within the citadel, except as specified in [2.2.2].

2.1.3 Means of monitoring the overpressure in the citadel with indication at the damage control station are to be provided and an alarm is to be activated at the damage control station and at the navigation bridge in case the overpressure drops below the required minimum level.

2.1.4 The ventilation system is to be sized so as to provide breathable air in the whole citadel during the expected duration of CBRN operation. The maximum number of people on board is to be taken into account for this purpose as well as the air consumption of any equipment located in the citadel and which may need to be used during CBRN operation.

Expected leakage through citadel boundaries, including sealed openings, is to be considered.

2.1.5 The sizing of the ventilation system is to be documented in a detailed calculation, in line with ANEP-25:1991 or with another recognized standard acceptable to the Society, supported by a drawing showing air flowrates and pressure levels in each part of the citadel.

2.1.6 Ventilation fans are to be located downstream of the CBRN filters.

2.1.7 Exhaust air from the citadel may be used for the ventilation of:

- other spaces in the citadel, including machinery spaces included in the citadel, or
- airlocks, or
- cleansing stations.

2.1.8 Where needed, non-return devices or dampers are to be fitted on ventilation ducts in order to maintain the required overpressure in the protected spaces and to prevent air flow from outside or decontamination spaces towards protected spaces or from machinery spaces towards other spaces.

2.1.9 Parts of the ventilation system not fully complying with the requirements of Pt C, Ch 4, Sec 5, [6] may be accepted provided that:

- they are used solely during CBRN operation, and suitably marked to this end, and
- they are separated from parts of the ventilation system that will be used during normal operation, to the satisfaction of the Society, and
- the ventilation system in use during normal operation is fully compliant with the requirements of Pt C, Ch 4, Sec 5, [6], and
- arrangements are made to prevent the fire extinguishing medium, especially CO_2, from leaving the protected space in case of release during CBRN operation or normal operation.

2.1.10 Ventilation inlets for the citadel are to be widely separated from any ventilation outlets. As a reference, ventilation outlets located more than 1,5 m away from the citadel ventilation inlets are considered widely separated.

2.2 Ventilation of machinery spaces or hazardous spaces included in the citadel

2.2.1 This sub-article applies to machinery spaces or spaces where an explosive atmosphere may occur, when such spaces are included in the citadel. These spaces are referred to as machinery or hazardous spaces included in the citadel.

2.2.2 The ventilation system for machinery or hazardous spaces included in the citadel is to be capable of maintaining an overpressure of at least 200 Pa with respect to the atmospheric pressure. Machinery or hazardous spaces included in the citadel are to remain at an underpressure of at least 100 Pa with respect to other spaces included in the citadel.

2.2.3 During CBRN operation, machinery or hazardous spaces included in the citadel may be ventilated with exhaust air from other spaces in the citadel, subject to the provisions of [2.1.9] and provided that:

- the levels of CO_2 and oxygen remain acceptable for personnel to work in the space without breathing apparatus, and
- non-return valves are fitted in the ventilation ducts in order to maintain the differential pressure between machinery or hazardous spaces and other spaces included in the citadel.

2.3 CBRN protection plant

2.3.1 The CBRN protection plant is to include gas and particulate filters capable of efficiently removing all CBRN agents listed in the CBRN operation specification

- the CBRN gas filters are to be activated carbon filters capable of eliminating chemical agents and other gases
- the CBRN particulate filters are to be high efficiency particulate air (HEPA) filters realizing a collection efficiency as specified by the Naval Authority in the CBRN operation specification. Where no collection efficiency is specified by the Naval Authority, the particulate filters are to realize a collection efficiency H13 according to EN 1822-1 or a collection efficiency of 99.97% of particles of 0,3 μm or greater.

2.3.2 The air inlet for the protection plant is to be provided with devices preventing water, moisture, particulate and corrosive marine salts from entering the CBRN filtration system. In addition, pre-filters are to be provided so that the quality and humidity content of the air blown on the CBRN filter is in line with manufacturer's specification.

2.3.3 Filters are to be easy to change.

2.3.4 A damper is to be installed downstream of the CBRN filters. This damper is to be interlocked with the inlet fan and open only when the inlet fan is working and blowing air towards the citadel.

2.4 Airlocks and cleansing stations

2.4.1 Airlocks and cleansing station enclosures are to be provided with a mechanical ventilation capable of providing at least 40 air changes per hour.

2.4.2 Airlocks and cleansing stations are to be supplied with decontaminated air. Exhaust air from the citadel may be used for this purpose, provided non-return devices are installed as relevant.

2.4.3 Exhaust air from a cleansing station enclosure with a higher overpressure (i.e. closer to the citadel) may be used as supply for the adjacent enclosure with a lower overpressure (i.e. closer to the open deck), provided non-return devices or dampers are installed as relevant.

2.4.4 Ventilation exhausts from airlocks and cleansing stations are to be led to the adjacent cleansing station enclosure with a lower overpressure (i.e. closer to the open deck) or to the open deck, and provided with non-return devices or dampers as necessary to avoid airflow from the outside towards inside the airlock or cleansing station enclosures.

3 Air blast resistance

3.1 Application

3.1.1 The requirements of this article apply to ships to be assigned the additional class notation **CBRN-AIR BLAST RESISTANCE**.

3.2 Protection of ventilation openings

3.2.1 The ventilation openings of spaces included in the citadel are to be capable of withstanding a blast overpressure of 70 mbar.

3.2.2 Ventilation openings that need to remain open during CBRN operation are to be provided with means of closing controllable from the damage control station.

3.3 Protection of collective protection system air inlet

3.3.1 The air inlet for the CBRN protection plant is to be provided with an air blast protective device able to withstand 0,3 bar overpressure. The air blast protective device is to be installed upstream of the filters.

4 Pre-wetting and washdown system

4.1 System arrangement

4.1.1 The ship is to be provided with a pre-wetting and washdown system capable of providing continuous and complete coverage of all external horizontal and vertical surfaces of superstructures and weather decks.

Any equipment installed on open deck is to be covered by this system, unless specified otherwise in the CBRN operation specification.

4.1.2 The capacity of the pre-wetting and washdown system is to be not less than 60L/min for each square meter of horizontally projected protected area for the most demanding section.

Lower flowrates may be accepted if specified by the Naval Authority taking into account the ship’s operational profile.

4.1.3 Nozzles are to be so arranged that all parts of the protected surfaces can be covered by a film of water.

4.1.4 The pre-wetting and washdown system may be divided into sections capable of being operated independently.

4.2 System equipment

4.2.1 The pre-wetting and washdown system may share pumps and/or piping with other systems, including fire-fighting systems. In this case, the pump capacity is to be sufficient to supply either the pre-wetting and washdown system or the other system(s).

4.2.2 The pump and section valves are to be capable of local and remote operation from the damage control station. Indication of each section valve's open or closed position and of whether the pump is in operation is also to be provided at this location and at the navigation bridge.

4.2.3 Pipes, valves and nozzles are to be protected against corrosion and are to comply with the relevant requirements of Pt C, Ch 1, Sec 10.

4.2.4 Means are to be provided to flush the system with fresh water and drainage cocks are to be installed. Precautions are to be taken in order to prevent clogging of the nozzles by impurities contained in pipes, nozzles, valves and pumps.

5 Personal protective equipment (PPE)

5.1 General

5.1.1 A sufficient number of complete sets of protective equipment is to be carried on board, according to the scope defined in the CBRN operation specification.

5.1.2 A set of protective equipment is to consist of:

- CBRN suit
- CBRN gloves and shoes
- Breathing apparatus with adequate CBRN mask.

In addition, prophylactic kits adapted to the risks expected according to the CBRN operation specification are to be provided as relevant.

5.2 Self-contained breathing apparatus

5.2.1 The ship is to be equipped with at least one high pressure air compressor complete with all fittings necessary for refilling the bottles of air breathing apparatuses.

5.2.2 The aggregate capacity of the compressors is to be sufficient to allow the refilling of n bottles for air breathing apparatuses in no more than 10min. n is the number of persons that may be engaged simultaneously in a CBRN operation requiring wearing Personal Protective Equipment (PPE) as defined in the CBRN operation specification.

5.2.3 It is to be possible to supply the air compressors with clean air from the citadel.

5.2.4 If the main air intake for the compressors is located outside of the citadel, an interlock with the CBRN detection system is to be provided to avoid contamination of the breathable air system.

5.2.5 Air supply for the air compressors is to be taken into account for the sizing of the citadel ventilation system.

6 Monitoring and Controls

6.1 Monitoring and control centralisation

6.1.1 All monitoring and control equipment relevant for CBRN operation is to be provided at the damage control station.

6.1.2 Tab 2 summarizes monitoring and control requirements for CBRN systems.

Table 2 : Summary of monitoring and control requirements for CBRN systems (during CBRN operation)

System		Indication	Alarm	Control	Note
CBRN detection system	CBRN contamination detection outside	• Damage control station • Navigation bridge	Audible and visual alarm: • Navigation bridge • Damage control station	Damage control station	See [1.2]
	CBRN contamination detection in the citadel	• Damage control station • Navigation bridge	Audible and visual alarm: • Navigation bridge • Damage control station • Throughout the citadel	Damage control station	See [1.2]
CBRN collective protection ventilation system	Differential pressure between citadel and outside atmosphere	Damage control station	• Damage control station • Navigation bridge		See [2.1.3]
	Differential pressure between machinery space and other spaces in the citadel	Damage control station	• Damage control station • Navigation bridge		See [2.1.3]
	Differential pressure between enclosed engine casing and machinery space	Damage control station	• Damage control station • Navigation bridge		See [2.1.3]
	Position of liquid and gastight closing appliances in the citadel and shelter boundaries	Damage control station		Local and remote at the damage control station	See Ch 8, Sec 2, [1.4.5] and Ch 8, Sec 2, [3.2.1]
	Doors and hatches in citadel or shelter boundaries	Damage control station		Damage control station **(1)**	See Ch 8, Sec 2, [1.4.5] and Ch 8, Sec 2, [3.2.1]
	Airlock and cleansing station doors	Damage control station	Alarm at the damage control station in case more than one door is open		See Ch 8, Sec 2, [4.2.3] and Ch 8, Sec 2, [5.2.4]
	Isolation valves in piping system	Damage control station		Local and remote, inside the citadel	See Ch 8, Sec 4, [1.1]
Pre-wetting and washdown system	Pump	• Damage control station • Navigation bridge		Local and remote from the damage control station	See [4.2.2]
	Section valves	• Damage control station • Navigation bridge		Local and remote from the damage control station	See [4.2.2]

(1) Remote control is not required for doors and hatches that are required to be closed during CBRN operation.

Section 4 Piping and Electrical Equipment

1 Piping systems

1.1 General

1.1.1 Piping systems not serving the citadel are not to pass through the citadel unless:

- Open-ended lines crossing the citadel are fully welded, and
- Isolation valves are provided at penetrations of the boundaries of the citadel. These valves are to be operable from inside the citadel and indication of their position is to be provided at the damage control station, unless otherwise specified by the Naval Authority.

1.1.2 In general, separate piping systems are to be provided to serve:

- the citadel
- shelters, if any
- airlocks and cleansing stations
- other unprotected spaces.

On a case-by-case basis, the Society may accept other arrangements if needed for operational reasons, provided isolation valves are fitted where boundaries between the above spaces are penetrated. These valves are to be operable from inside the citadel. Indication of their position is to be provided at the damage control station, and they are to be marked in line with the requirements of Ch 8, Sec 2, [7.2].

1.1.3 Sea suctions serving the fire main, decontamination showers, cooling systems, and pre-wetting and washdown system where provided, are to be located as low as possible.

1.2 Scupper and bilge systems

1.2.1 Separate scupper and bilge systems are to be provided for:

- the citadel
- shelters, if any
- airlocks and cleansing stations
- other unprotected spaces

1.2.2 Scupper and bilge systems are to be sized taking into account decontamination systems, i.e. decontamination showers in cleansing stations and pre-wetting and washdown system.

1.2.3 Drainage from the cleansing stations and external decontamination showers is to be led directly overboard.

1.2.4 Scuppers from spaces within the citadel or the shelter, and from airlocks and cleansing stations are to be fitted with adequate devices, such as water traps, that will preserve the required overpressure in the protected spaces and prevent the ingress of external air.

1.2.5 Separate scupper and bilge systems are to be provided for spaces that are maintained at different overpressure during CBRN operation.

1.3 Air, sounding and overflow pipes

1.3.1 The potable water tank venting is to be led inside the citadel.

1.3.2 Vent pipes and filling connections of service tanks are to be arranged so that hazardous material cannot enter the tanks during CBRN operation.

2 Electrical installations

2.1 Environmental protection

2.1.1 Electrical equipment included in electrical installations for essential services and located in the citadel or shelter is to have environmental category (EC) of at least EC 31 C or EC 33 C as applicable. Environmental categories are defined in Pt C, Ch 2, Sec 1, [3.14.1].

2.1.2 Where needed, means of refrigeration are to be provided and systems are to withstand the maximum temperature expected in CBRN condition. If the local temperature around the equipment may be expected to rise above 55°C, specific testing may be required.

2.2 Emergency source of power

2.2.1 The following systems are to be supplied by the emergency source of power:

- CBRN detection system
- control and monitoring of openings in citadel boundaries.

Part E
Additional Class Notations

CHAPTER 9
MANOEUVRABILITY, STABILITY AND SEA-KEEPING

Section 1 Manoeuvrability (MANOVR)

1 General

1.1 Introduction

1.1.1 Ship manoeuvrability

The manoeuvrability of a ship include the stability of a steady state motion with “fixed controls” as well as the time dependent responses that result from the control actions used to maintain or modify steady motion, make the ship follow a prescribed path or initiate an emergency manoeuvre.

1.1.2 Manoeuvrability criteria

Some of the control actions are considered to be especially characteristic of ship manoeuvring performance and therefore are required to meet a certain minimum standard. The minimum standard is here considered to be the criteria given in IMO Resolution MSC.137(76) (Explanatory notes to this resolution are given in IMO MSC/Circ.1053). Based on compliance with these requirements, the Society can release the additional class notation **MANOVR-IMO**.

The additional class notation **MANOVR-IMO** cannot be granted for ships subject to high speed criteria. The high speed criteria are given as follows:

- Pt D, Ch 3, Sec 2, [1.1.2] for the service notation **corvette**
- Pt D, Ch 6, Sec 1, [1.2.1] for the service notation **military OPV**
- Pt D, Ch 7, Sec 2, [2.1.2] for the service notation **landing craft**.

In some cases the Naval Authority might wish to ensure a higher level of manoeuvring performance. In the following a different set of manoeuvring criteria, suitable for high performance military vessels, is given. By documenting compliance with these criteria the Society can release the additional class notation **MANOVR-MIL**.

1.1.3 Verification approach

It is a basic requirement that compliance with manoeuvrability criteria is to be demonstrated by full scale trials. The additional notations **MANOVR-IMO** and **MANOVR-MIL** can only be released when complete compliance with the relevant criteria has been demonstrated by means of full-scale trials.

1.1.4 Application

The following sections apply to all vessels. This is also the case when the **MANOVR-IMO** notation is requested; the IMO criteria should also be fulfilled for vessels with L<100m, where L is the rule length in m.

2 Manoeuvrability criteria

2.1 Standard manoeuvres

2.1.1 Terminology

The standard manoeuvres and associated terminology are as defined below:

a) Test speed (V) is a speed of at least 90% of the ship's speed corresponding to 85% of the maximum engine output.

b) Turning circle manoeuvre is the manoeuvre to be performed to both starboard and port with 35° rudder angle or the maximum rudder angle permissible at the test speed, following a steady approach with zero yaw rate.

c) Advance is the distance travelled in the direction of the original course of the midship point of a ship from the position at which the rudder order is given to the position at which the heading has changed 90° from the original course.

d) Tactical diameter is the distance travelled by the midship point of a ship from the position at which the rudder order is given to the position at which the heading has changed 180° from the original course. It is measured in a direction perpendicular to the original heading of the ship.

e) Zig-zag test is the manoeuvre where a known amount of helm is applied alternately to either side when a known heading deviation from the original heading is reached.

f) 10°/10° zig-zag test is performed by turning the rudder alternately 10° to either side following a heading deviation of 10° from the original heading in accordance with the following procedure:
   - After a steady approach with zero yaw rate, the rudder is put over to 10° to starboard/port (first execute)
   - When the heading has changed to 10° off the original heading, the rudder is reversed to 10° port/starboard (second execute)
   - After the rudder has been turned to port/starboard, the ship will continue turning in the original direction with decreasing turning rate. In response to the rudder, the ship should then turn to port/starboard. When the ship has reached a heading of 10° to port/starboard of the original course the rudder is again reversed to 10° to starboard/port (third execute).

g) The first overshoot angle is the additional heading deviation experienced in the zig-zag test following the second execute.

h) The second overshoot angle is the additional heading deviation experienced in the zig-zag test following the third execute.

i) 20°/20° zig-zag test is performed using the procedure given for the 10°/10° zig-zag test, using 20° rudder angles and 20° change of heading.

j) Full astern stopping test determines the track reach of a ship from the time of an order of full astern is given until the ship stops in the water.

k) Track reach is the distance along the path described by the midship point of a ship measured from the position at which an order for full astern is given until the ship stops in the water.

l) Inherent dynamic stability; a ship is dynamically stable on a straight course if it, after a small disturbance, soon will settle on a new straight course without any corrective rudder.

m) Pull-out manoeuvre determines the ships dynamic stability. After the completion of the turning circle test the rudder is returned to the midship position and kept there until a steady turning rate is obtained. If the ship is stable the rate of turn will decay to zero for turns to both port and starboard. If the ship is unstable then the rate of turn will reduce to some residual rate of turn.

2.2 Criteria

2.2.1 The criteria related to the **MANOVR-MIL** notation are given in Tab 1.

Table 1 : Manoeuvrability criteria

Test	Criteria
Turning circle manoeuvre • advance • tactical diameter	 4,5 L 5,0 L
Initial turning ability	With the application of 10° rudder angle to port/starboard, the ship should not have travelled more than 2,5L by the time the heading angle has changed by 10° from the original heading.
10°/10° zig-zag test	First overshoot angle should not exceed 10°; Second overshoot angle should not exceed the above by more than 15°.
20°/20° zig-zag test	First overshoot angle should not exceed 20°.
Stopping ability	The track reach in full astern **(1)** stopping test should not exceed 10 L.
Dynamic stability, pull-out test	After the completion of the turning circle test the rudder is returned to the midship position and kept there until a steady turning rate is achieved. This turning rate should be zero.
(1) Power corresponding to 85% of the maximum continuous power.	

3 Full scale trials

3.1 General

3.1.1 Scope of trials

Full scale trials must be carried out in order to demonstrate that a vessel complies with the manoeuvring criteria given in:

- [2.2] in cases where the **MANOVR-MIL** notation is considered
- IMO Resolution MSC.137(76) in cases where the **MANOVR-IMO** notation is considered.

3.2 Trials conditions

3.2.1 General

In order to evaluate the performance of a ship, manoeuvring trials should be conducted to both port and starboard and at conditions specified below:

a) deep, unrestricted water

b) calm environment

c) full or operational load, even keel condition

d) steady approach at the test speed.

The above conditions are further described in the following sections.

3.2.2 Deep, unrestricted water

Manoeuvrability of a ship is strongly affected by interactions with the bottom of the waterway, banks and passing vessels. Trials should therefore be carried out in deep, unconfined but sheltered waters. Following minimum requirement to the water depth applies:

- The water depth should exceed four times the mean draught of the vessel.

3.2.3 Environmental conditions

Trials should be carried out in the calmest weather conditions possible. Wind, waves and current can significantly affect trials results, having a more pronounced effect on smaller ships. Trials are to be conducted in conditions within the following limits:

- Wind: not to exceed Beaufort 5 (< 9,4 m/s)
- Wave: not to exceed sea state 4 (H_S < 2,5 m)
- Current: uniform only.

The environmental conditions should be carefully recorded before and after trials so that corrections of the trials results can be applied. Corrections according to IMO MSC/Circ.1053, section 3.4.2, of 16 December 2002 may be applied. As a minimum following environmental data must be recorded:

- Water depth
- Waves: the sea state should be noted. If there is a swell, period and directions must be noted
- Current: the trials should be conducted in a well surveyed area and the condition of the current noted from relevant hydrographical data. Correlation shall be made with the tide
- Weather conditions, including visibility, should be observed and noted.

3.2.4 Loading condition

The manoeuvring trials should be carried out in following loading conditions:

- Auxiliary ships: full load condition
- Front and second line ships: at a displacement contained between the average operational displacement and the full load end of life displacement.

If these loading conditions are not achievable at the time of trials, the manoeuvrability of the ship may be determined by applying a correction to the results obtained from trials conducted in another loading condition. In this case, the corrections are to be applied in accordance with IMO MSC/Circ.1053, section 3.4.2, 16 December 2002 and to the satisfaction of the Society.

3.2.5 Steady approach

Prior to the start of the manoeuvring test the vessel must perform an approach run. The approach run means that below conditions must be fulfilled for at least two minutes preceding the test:

a) the ship speed must be steady and equal to the test speed, defined in [2.1.1]

b) the heading should be constant and preferably head to the wind

c) engine control setting to be kept constant.

3.3 Trials to be carried out

3.3.1 General

In order to demonstrate compliance with the manoeuvring criteria, following full scale trials are to be carried out:

- turning circle manoeuvre
- 10° zig-zag manoeuvre
- 20° zig-zag manoeuvre
- stopping test
- pull-out manoeuvre.

All trials must be carried out according to the descriptions in IMO MSC/Circ.1053, 16 December 2002.

3.4 Documentation to be submitted

3.4.1 The following documentation is to be submitted:

- for information, before the execution of the sea trials: sea trials specifications
- for approval, report on the sea trials results.

Section 2 Stability Criteria for Auxiliary Naval Vessels (VLS)

1 General

1.1 Application

1.1.1 This Section applies to ships assigned the service notation **auxiliary naval vessel** as defined in Pt A, Ch 1, Sec 2, [4.5] and which are in compliance with the military criteria for hull arrangement and stability given in Part B.

Ships complying with the requirements of this Section are eligible for assignment of the additional class notation **VLS**.

2 Hull arrangement and stability

2.1 General arrangement design

2.1.1 Ships provided with the additional class notation **VLS** are to comply with the requirements of Part B for hull general arrangement and design.

Note 1: above listed requirement replace requirements of Part D, Chapter 4 where Part D, Chapter 4.

2.2 Stability

2.2.1 Intact stability

Ships provided with the additional class notation **VLS** are to comply with the requirements of Pt B, Ch 3, Sec 1 and Pt B, Ch 3, Sec 2 for intact stability.

Note 1: above listed requirement replace the requirements of Part D, Chapter 4 regarding intact stability.

2.2.2 Damage stability

Ships provided with the additional class notation **VLS** are to comply with the requirements of Pt B, Ch 3, Sec 3 for damage stability, as applicable for a ship of Category II as defined in Pt B, Ch 3, Sec 3, [2.4.2] a).2).

Note 1: above listed requirement replace the requirements of Part D, Chapter 4 regarding damage stability.

Section 3 Sea-Keeping Assessment (SEA-KEEP)

1 General

1.1 Introduction

1.1.1 Sea-keeping notations

The confidential additional class notation **SEA-KEEP** is assigned to ships whose specific sea-keeping performance levels are assured up to a certain limiting sea state.

The **SEA-KEEP** notation is completed, as applicable, by a combination of:

- notations specific to the type of ship capability:
  - **FLY**, for flight operations, as given in [1.1.4]
  - **RAS**, replenishment at sea, as given in [1.1.5]
  - **WEAP**, for weapons systems operations, as given in [1.1.6]
  - **CREW**, for crew capability, as given in [1.1.7]
  - **BOAT**, for small craft operations, as defined in [1.1.8].
- notations detailing the specific capabilities and criteria assessed as per [2.1.2], [3.1.2], [4.1.2], and [6.1.2].
- a notation **X(L,M,H)** where **X** specifies the limiting sea state number and **L**, **M** and **H** further specify the degree of severity (Low, Medium, High) of the sea state considered among those characterized by the number, up to and including which the required sea-keeping performance is maintained.

For example, the additional notation **SEA-KEEP-FLY_CTOL-3(H)** is assigned to a ship that can satisfy the flight operation limits for launch and recovery of conventional take-off and landing aircraft in seas up to and including high sea state 3.

1.1.2 Operation limits

The operation limits depend on the specific operation the vessel must perform and are taken according to NATO STANAG 4154 Ed.4. For flight, replenishment at sea (RAS), weapons systems, crew performance and small boat operations, the limits ensure that:

- aircraft/helicopters can be launched, recovered and handled
- RAS operations can be carried out safely and effectively
- weapons systems can be operated and handled safely and effectively
- crew members are capable of performing the tasks connected to transit missions
- small craft can be launched and recovered.

1.1.3 Verification approach

The additional notation **SEA-KEEP** is assigned to ships when the limiting sea state **X** for the specific operation has been determined by the use of sea-keeping computer calculations or small-scale model tests in a model basin according to the procedure defined in [1.2].

1.1.4 Flight operations (FLY)

In terms of sea-keeping effects on performance, the **FLY** notation covers operations including

- launch and recovery of conventional take-off & landing (CTOL) aircraft
- launch and recovery of short take-off & vertical landing (STOVL) and vertical take-off & landing (VTOL) aircraft, including helicopters
- near-ship operations (e.g. helicopter in-flight refueling
- on-deck handling (e.g. fueling, folding wings or rotors, transit into hangar).

1.1.5 Replenishment at sea (RAS)

The **RAS** notation covers replenishment at sea operations which may represent a wide variety of resupply activities, including:

- connected replenishment (CONREP)
- fueling at sea (FAS)
- vertical replenishment (VERTREP).

CONREP operations involve two (or more) ships that are connected by flexible umbilicals and/or constant tension wire rigging to exchange personnel and supplies such as munitions and general stores.

FAS operations involve two (or more) ships that are connected by flexible umbilicals to exchange fuel.

VERTREP operations cover operations where a helicopter is used to lower personnel and/or materials onto the ship.

1.1.6 Weapons systems operation (WEAP)

The **WEAP** notation covers weapons systems operations which represent the missions where the crew must operate or handle the on-board weapons systems, including:

- operation of radars and sonars
- operation of guns
- launching/handling of missiles
- launching/handling of torpedoes.

1.1.7 Crew performance (CREW)

The **CREW** notation covers crew performance which includes the tasks a crew may be required to perform during the TRAN mission as defined in Pt B, Ch 3, Sec 4, [1.1.4].

1.1.8 Small craft operations (BOAT)

The **BOAT** notation covers small craft operations which include the launch and recovery of small craft and depends upon the type of system implemented, as follows:

- stern and side (davit) launch and recovery
- stern ramp launch and recovery.

1.2 Assessment procedure

1.2.1 Parameters

The parameters to be considered for the sea-keeping assessment are defined in Articles [2], [3], [4], [5] and [6].

1.2.2 Evaluation

The values of the ship sea-keeping parameters are to be assessed by means of computer calculations and/or small scale model tests in a model basin.

The computer calculations are to be performed as described in Pt B, Ch 3, App 6, and the following documentation is to be provided:

- justification of the validity of the used software
- parameters to be calculated
- computation input data
- computation results
- model test results that verify and/or replace calculated results.

For model tests, the following documentation is to be provided:

- parameters to be measured
- detailed test program
- analysis procedure of measured data
- sea and ship loading condition during the tests
- test results and their analysis.

1.3 Environmental conditions

1.3.1 Sea state

Sea state is an expression used to categorize wave conditions and normally a sea state comprises a significant wave height Hs and a wave period.

Unless otherwise specified, the environmental conditions for sea-keeping analyses or model tests are to be selected and applied in accordance with NATO STANAG 4154 Ed.4. The wave spectrums to be considered are described in Pt B, Ch 3, App 6. Further guidance is available in NI 691 Environmental Conditions, Loads and Induced Responses of Marine Units.

Whenever computer calculations or scale model tests are used, (i.e. when the environmental conditions are selectable), the sea states used for the verification of the criteria in [2.2], [3.3], [4.3], [5.3] and [6.2] are to be defined as described in [1.3.2] and [1.3.3].

The limiting sea state denoted by **X(L,M,H)** defines the sea state up to and including which the sea-keeping criteria can be satisfied for any particular operation or capability. **X** specifies the sea state number and **L**, **M** and **H** further specify the degree of severity (Low, Medium, High) as per [1.3.2].

1.3.2 Wave height

In general, references to wave height are to be taken as the significant wave height Hs (i.e. the average of the 1/3 largest wave heights in a sea state).

The description of sea states found in STANAG 4154 defines the significant wave height as ranges, not absolute values. For this reason sea states must be referred to not just by their number, but also whether it is a low, mid or high sea state (L, M or H). For example, for the sea states defined in accordance with STANAG 4154, low sea state 6 has Hs = 4,0 m, mid sea state 6 has Hs = 5,0 m and high sea state 6 has Hs = 6,0 m.

The wave height to be considered for the verifications is to be the largest significant wave height for the specified sea state; for example, if a mid sea state 6 is specified, Hs is to be taken as 5,0 m but if only sea state 6 is specified, Hs is to be taken equal to 6,0 m.

1.3.3 Wave period

In general, references to wave period are to be taken as the modal wave period, as per STANAG 4154.

For the TRAN mission defined in Pt B, Ch 3, Sec 4, [1.1.4], at least three periods are to be considered, the values of which are to be selected in accordance with STANAG 4154. For other cases, one period value will, in general, be sufficient.

1.3.4 Specific conditions

Specific conditions or exclusions that have been requested or approved by the Naval Authority may be taken into account if agreed with the Society.

2 Flight operations (FLY)

2.1 General

2.1.1 Scope

The sea-keeping performance is to be evaluated in order to determine in what sea state the ship motions and accelerations become so severe that they prevent or obstruct the conduct of flight operations.

2.1.2 Requirements

It is to be ensured that relevant flight operations can be conducted by verifying that the parameters evaluated do not exceed the criteria defined in [2.2].

The limiting sea state **X(L,M,H)** is to be determined and included with each relevant **FLY** notations as follows:

- **_CTOL**: criteria specific to launch and recovery of fixed wing (CTOL) aircraft, as given in [2.2.1]
- **_FWAH**: criteria specific to fixed wing (CTOL) aircraft handling, as given in [2.2.2]
- **_HELOL**: criteria specific to launch and recovery of VTOL and STOVL aircraft, including helicopters, as given in [2.2.3]
- **_HELOH**: criteria specific to handling of VTOL and STOVL aircraft, including helicopters, as given in [2.2.4].

2.2 Criteria

2.2.1 Fixed wing aircraft launch & recovery

Limits for CTOL of fixed wing aircraft from aircraft carriers are listed in Tab 1.

Table 1 : Fixed wing aircraft launch & recovery criteria limits

Governing factors	Performance limitations		
	Motion	Limit	Location
Aircraft handling	Roll	See roll criteria, Fig 1	
Sink off bow and optical landing system (OLS) limits	Pitch	See pitch criteria, Fig 2	
Ramp clearance	Vertical displacement	0,8 m	Stern ramp at flight deck
Landing line-up	Lateral displacement	2,3 m	Stern ramp at flight deck
Landing gear	Vertical velocity	0,7 m/s	Touch down point
Note 1: All limits are given in terms of RMS amplitude			

Figure 1 : Roll limits

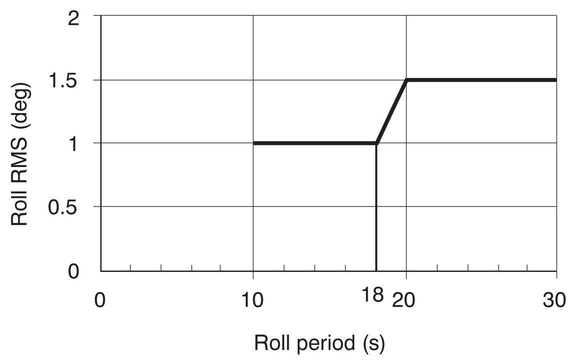
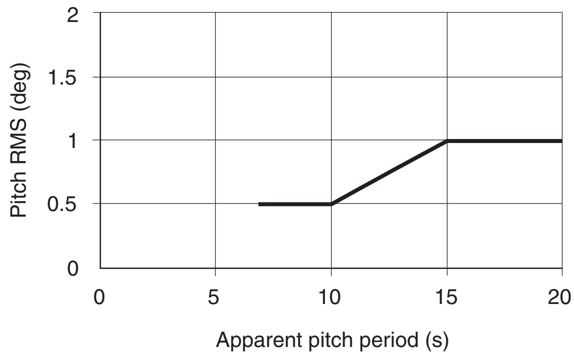


Figure 2 : Pitch limits



2.2.2 Fixed wing aircraft handling

Limits on support equipment for fixed wing (CTOL) aircraft handling are given in Tab 2. Support operations encompass a wide range of functions (e.g. ordnance handling, aircraft arming, fueling, engine changing). As such, the limits for support equipment are presented for the most restrictive of these functions.

Table 2 : Fixed wing aircraft handling criteria limits

Subsystem	Performance limitations		
	Motion	Limit	Location
Aircraft and handling equipment	Roll	See roll criteria, Fig 1	
	Pitch	See pitch criteria, Fig 2	
Elevators	Wetness	5/hr	Bottom inner leading elevator edge

2.2.3 VTOL and STOVL aircraft launch and recovery

Limits for launch & recovery of VTOL and STOVL aircraft, including helicopters, are given in Tab 3.

Table 3 : VTOL and STOVL aircraft launch and recovery criteria limits

Operation	Performance limitations		
	Motion	Limit	Location
Generic VTOL/ helicopter launch	Roll	2,5°	
	Pitch	1,5°	
Generic short takeoff	Roll	2,5°	
	Pitch	1,5°	
Generic VTOL / helicopter recovery	Roll	2,5°	
	Pitch	1,5°	
	Vertical velocity	1,0 m/s	Landing point
Note 1: All limits are given in terms of RMS amplitude.			

2.2.4 Helicopter and STOVL aircraft handling

Limits for handling of helicopter VTOL and STOVL aircraft, including helicopters, are given in Tab 4.

Alternative performance limits specified by the Designer may be applied to specific aircraft types, subject to agreement with the Society and the Naval Authority. These alternative limits are to be consistent with the performance capabilities of the handling equipment and operations performed and are to be defined for the most restrictive functions for each type of handling equipment.

In all cases, when deck crew are involved in handling operations, the personnel criteria in Tab 14 are also to be applied.

Table 4 : VTOL and STOVL aircraft handling criteria limits

Performance limitations	
Motion	Limit
Roll	1,8°
Pitch	1,8°
Note 1: All limits are given in terms of RMS amplitude.	

3 Replenishment at sea (RAS)

3.1 General

3.1.1 Scope

The sea-keeping performance is to be evaluated in order to determine in what sea state the ship motions and accelerations become so severe that they prevent or obstruct RAS operations.

3.1.2 Requirements

It is to be ensured that the systems and crew are able to fulfil the functions related to relevant RAS operations by verifying that the parameters evaluated do not exceed the criteria defined in [3.3].

The limiting sea state **X(L,M,H)** is to be determined and included with each relevant **RAS** notation as follows:

- **_CONREP**: criteria specific to “Connected replenishment”, as given in [3.3.1]
- **_FAS**: criteria specific to “Fuelling at sea”, as given in [3.3.2]
- **_VERTREP**: criteria specific to “Vertical replenishment”, as given in [3.3.3].

3.2 Parameters

3.2.1 Motion Induced Interruption

The motion induced interruption (MII) is defined in [5.2.1].

3.3 Criteria

3.3.1 Connected replenishment (CONREP)

Limits for CONREP between two ships are listed in Tab 5.

3.3.2 Fuelling at sea (FAS)

Limits for FAS between two ships are listed in Tab 6.

3.3.3 Vertical replenishment (VERTREP)

Limits for VERTREP from helicopters are listed in Tab 7.

Table 5 : CONREP criteria limits

Limiting factor	Performance limitations		
	Motion	Limit	Location
Equipment: Pallet truck slip angle	Roll	2,2°	
	Pitch	2,2°	
Personnel	MII	0,5/min	CONREP station
	Vertical acceleration	0,2g	CONREP station
	Wetness index	0,5/hr	CONREP station
Note 1: Roll, pitch and vertical acceleration limits are given in terms of RMS amplitude.			

Table 6 : FAS criteria limits

Limiting factor	Performance limitations		
	Motion	Limit	Location
Personnel	MII	0,5/min	FAS station
	Vertical acceleration	0,2g	FAS station
	Wetness index	0,5/hr	FAS station
Note 1: The vertical acceleration limit is given in terms of RMS amplitude.			

Table 7 : VERTREP criteria limits

Limiting factor	Performance limitations		
	Motion	Limit	Location
Helicopter-to-ship	Vertical displacement	0,7m	VERTREP station
	Vertical velocity	1,05m/s	VERTREP station
Equipment: Missile dolly slip angle	Roll	1,6°	
	Pitch	1,6°	
Personnel	MII	0,5/min	VERTREP station
	Vertical acceleration	0,2g	VERTREP station
	Wetness index	0,5/hr	VERTREP station
Note 1: Roll, pitch, vertical displacement and velocity limits are given in terms of RMS amplitude.			

4 Weapons systems (WEAP)

4.1 General

4.1.1 Scope

The sea-keeping performance is to be evaluated in order to determine in what sea state the ship motions and accelerations become so severe that weapons system performance may be unacceptably degraded.

4.1.2 Requirements

It is to be ensured that weapons system performance will remain acceptable by verifying that the parameters evaluated do not exceed the criteria defined in [4.3] for relevant systems.

The limiting sea state **X(L,M,H)** is to be determined and included with each relevant **WEAP** notation as follows:

- **_R** : criteria specific to “radar”, as given in [4.3.1]
- **_S** : criteria specific to “sonar”, as given in [4.3.2]
- **_TM** : criteria specific to “trainable missile”, as given in [4.3.3]
- **_VM** : criteria specific to “vertical launch system”, as given in [4.3.3]
- **_T** : criteria specific to “torpedo system”, as given in [4.3.4]
- **_E** : criteria specific to “support equipment”, as given in [4.3.5]
- **_G** : criteria specific to “guns”, as given in [4.3.6].

4.2 Parameters

4.2.1 Motion Induced Interruption

The motion induced interruption (MII) is defined in [5.2.1].

4.3 Criteria

4.3.1 Radars

For air search/surface surveillance radars with elevation-stabilised antennas, the maximum design roll angle is 25 degrees for 100% effective performance and 30 degrees for 0%. These values are rarely limiting. Mission performance will most likely depend upon motion limits on other subsystems.

4.3.2 Sonars

Degradation of hull mounted sonar performance will occur due to the emergence of the sonar housing, modification of the signal caused by beam bearing fluctuation, and phase and frequency shift of the signal.

Full performance may be expected within the motion limits defined in Tab 8.

Table 8 : Sonar criteria limits

Hull mounted sonar	Performance limitations		
	Motion	Limit	Location
Active sonar	Emergence	24/hr	Leading edge of dome with hull
	Roll	7,5°	
	Pitch	2,5°	
Passive sonar	Emergence	90/hr	Leading edge of dome with hull
Note 1: Roll and pitch limits are given in terms of RMS amplitude.			

4.3.3 Missile systems

Maximum design limits for both trainable and vertical launch systems are given in Tab 9 and Tab 10.

It must be noted that the launch criteria apply only to the missile launch systems. For launch, the missiles themselves have limits on structural strength and controllability until their air speed is sufficient for aerodynamic control. Typically, the missile is held in the launcher until motions are within specified lockout limits, then they are launched. The missile lockout criteria are not available in an unclassified format.

The roll, pitch and yaw limits listed in Tab 10 for vertical launch system operations are associated with minimum natural periods of 9 seconds, 9 seconds and 6 seconds, respectively. The limiting values will decrease below the minimum periods.

Table 9 : Trainable missile system criteria limits

Subsystems limitations	Performance limitations	
	Motion	Limit
Launcher	Roll or pitch	3,8°
Missile handling - automatic operation	Roll or pitch	3,8°
Missile handling - manual operation	Roll or pitch	2,5°
Missile reloading	Roll or pitch	1,3°
Note 1: Limits are given in terms of RMS amplitude.		

Table 10 : Vertical launch system criteria limits

Operation	Performance limitations		
	Motion	Limit	Location
Launch	Roll	8,8°	
	Pitch	1,5°	
	Yaw	0,8°	
	Longitudinal acceleration	0,15g	Launcher outboard corner
	Transverse acceleration	0,35g	Launcher outboard corner
	Vertical acceleration	0,30g	Launcher outboard corner
Reloading at 10 missiles per hour	Roll	1,3°	
	Pitch	0,5°	
	Yaw	0,3°	
	Longitudinal acceleration	0,05g	Launcher outboard corner
	Transverse acceleration	0,05g	Launcher outboard corner
	Vertical acceleration	0,1g	Launcher outboard corner
Reloading at 3 missiles per hour	Roll	3,8°	
	Pitch	1,0°	
	Yaw	0,5°	
	Longitudinal acceleration	0,1g	Launcher outboard corner
	Transverse acceleration	0,15g	Launcher outboard corner
	Vertical acceleration	0,15g	Launcher outboard corner
Note 1: Limits are given in terms of RMS amplitude. **Note 2:** 1,0 g acceleration due to gravity has been subtracted from the vertical acceleration limits.			

4.3.4 Torpedo systems

The criteria limits for torpedo system operation are defined in Tab 11. The torpedo itself is not limited by ship motion during launch. Typically, heavier torpedoes and missiles must be loaded from dollies and thus the limits are somewhat more restrictive than for those that are loaded by hand.

Table 11 : Torpedo system criteria limits

Subsystems limitations	Performance limitations	
	Motion	Limit
Launcher	Roll or pitch	3,8°
Loading, torpedoes on dollies	Roll or pitch	1,3°
Loading by hand	Roll or pitch	1,5°
Automatic direct loading	Roll or pitch	3,8°
Note 1: Limits are given in terms of RMS amplitude.		

4.3.5 Support equipment

The criteria limits for support equipment operations are defined in Tab 12. Support operations encompass a wide range of functions (e.g. ordnance handling, arming, maintenance), hence the limits applicable to operation of support equipment are defined for the most restrictive of these.

Table 12 : Support equipment criteria limits

Performance limitations		
Motion	Limit	Location
Roll	1,8°	
Pitch	1,8°	
MII	1/min	Task location
Note 1: Roll and pitch limits are given in terms of RMS amplitude.		

4.3.6 Guns

Generic criteria for gun systems are provided in Tab 13. Accuracy of guns and fire control systems may be reduced because of ship motions.

Table 13 : Gun criteria limits

Representative gun system	Performance limitations		
	Motion	Limit	Location
5 inch/54	Roll	3,8°	Gun barrel tip
	Pitch	3,8°	Gun barrel tip
	Vertical velocity	0,5m/s	Gun barrel tip
Note 1: Limits are given in terms of RMS amplitude.			

5 Personnel performance (CREW)

5.1 General

5.1.1 Scope

The sea-keeping performance is to be evaluated in order to ensure that the ship motions and accelerations do not become so severe that they prevent the crew from carrying out their tasks related to operations conducted at specified locations, in weather conditions where the ship is expected to carry out the TRAN mission.

The evaluation excludes the impact of relative wind that may impact the ability of crew to work on open decks.

5.1.2 Requirements

It is to be ensured that the crew is able to carry out tasks related to the TRAN mission by verifying that the parameters evaluated do not exceed the criteria defined in [5.3], for all locations on board where crew may be present for both short and long durations.

The parameters evaluated are to comply with the criteria for a limiting sea state not less than mid sea state 5. Therefore, the **CREW** notation may only be assigned when the limiting sea state is not less than mid sea state 5. The limiting sea state **X(L,M,H)** is to be included with the **CREW** notation.

The Society may accept that the calculations consider the effect of active motion damping systems (anti-roll fins, T-foils etc.) if the suitability and efficiency of such systems can be demonstrated.

5.2 Parameters

5.2.1 Motion induced interruption

A motion induced interruption (MII) is an incident where ship motions cause a person to slide or lose balance, resulting in a stumble. Motion induced interruption not only represents a danger to the crew, but also prevents the crew from carrying out their tasks.

In order to determine the MII index, the so-called Generalised Lateral Force Estimator for tipping port (GLFEp) or starboard (GLFEs) is to be evaluated according to the following definitions:

$$GLFE_p = \frac{1}{3}ha_R - a_T - g\phi - \frac{b}{h}a_V$$

$$GLFE_s = \frac{1}{3}ha_R - a_T - g\phi + \frac{b}{h}a_V$$

where b and h are defined in Fig 3.

The ratio b/h is called lateral tipping coefficient and a representative value of 0,25 with h taken equal to 1,20 m can be assumed based on typical human dimensions.

The formula above must be interpreted as a linear combination of the transfer functions (in-phase, pedex C, and out-of phase, pedex S, components) of roll motion ϕ, roll acceleration a_R, transverse acceleration a_T and vertical acceleration a_V, which can be safely considered as a standard output from frequency-domain codes.

By definition of the generalised lateral force estimator, a tipping event occurs whenever the estimator exceeds the threshold level (b/h)g. In order to evaluate this occurrence frequency one has to rely upon standard spectral theory, which is routinely incorporated into frequency-domain sea-keeping codes.

The first step is to determine the in/out-of-phase components of the estimator, $GLEp,s_C$ and $GLEp,s_S$, and consequently its amplitude:

$$GLEp,s_a = \sqrt{(GLEp,s_C)^2 + (GLEp,s_S)^2}$$

The second step is the evaluation of its zero'th and second order spectral moments:

$$m_{0;p,s} = \int_{\omega_{min}}^{\omega_{max}} GLEp,s_a^2 \, S(\omega)d\omega$$

$$m_{2;p,s} = \int_{\omega_{min}}^{\omega_{max}} \left|\omega - \frac{\omega^2 V}{g}\cos\psi\right|^2 GLEp,s_a^2 \, S(\omega)d\omega$$

where $S(\omega)$ is the wave spectrum of the sea state, ω is the wave frequency in rad/s, V is the ship speed in m/s, ψ is the heading angle and g is the gravity acceleration in m/s^2.

The motion induced interruptions due to lateral tipping port/starboard $MII_{p,s}$ (in units of tipping events per minute) can thence be calculated as:

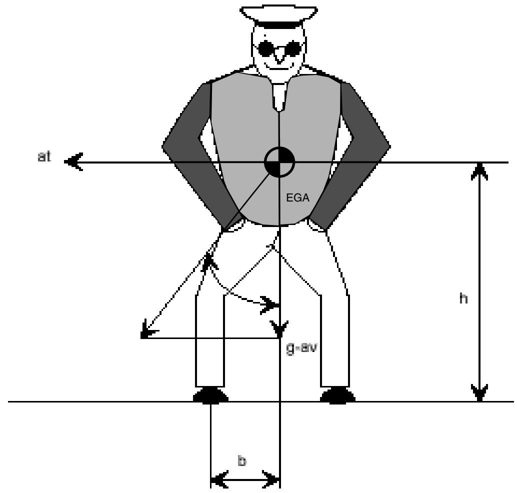
$$MII_{p,s} = \frac{60}{2\pi}\sqrt{\frac{m_{2;p,s}}{m_{0;p,s}}}\exp\left(-\frac{a^2}{2m_{0;p,s}}\right)$$

with a taken equal to (b/h)g

Finally, the MII can be determined as:

$MII = MII_p + MII_s$

Figure 3 : Definitions for generalised lateral force estimator



5.2.2 Seasickness incidence

Seasickness has a direct influence on the capacity of crew to carry out their duties. RMS vertical acceleration is correlated with the incidence of seasickness.

5.3 Criteria

5.3.1 Recommended criteria

The recommended criteria for verifying crew performance are given in Tab 14.

Table 14 : Recommended personnel criteria limits

Parameter	Limit	Location
Vertical acceleration	0,2g	bridge
MII	1/min	task location
Note 1: The vertical acceleration limit is given in terms of RMS amplitude.		

5.3.2 Default criteria

The default criteria for verifying crew performance are given in Tab 15.

Application of these criteria will only be accepted if it is not possible to calculate MII as per the recommended criteria in [5.3.1]. These criteria consist of the RMS amplitude value of the ship motions that contribute to MII.

Table 15 : Default personnel criteria limits

Parameter	Limit	Location
Pitch	1,5°	
Roll	4°	
Vertical acceleration	0,2g	Bridge
Lateral acceleration	0,1g	Bridge
Note 1: All limits given as RMS amplitude values.		

6 Small craft operations (BOAT)

6.1 General

6.1.1 Scope

The sea-keeping performance is to be evaluated in order to determine in what sea state the ship motions and accelerations become so severe that they prevent or obstruct the launch and recovery of small craft from the mothership.

6.1.2 Requirements

It is to be ensured that the crew is able to carry out their tasks related to the relevant type(s) of small craft launch and recovery operations by verifying that the parameters evaluated do not exceed the criteria defined in [6.2].

The limiting sea state **X(L,M,H)** is to be determined and included with each relevant **BOAT** notation as follows:

- **DECK**: criteria specific to "stern and davit (or side) launch and recovery of small craft"
- **RAMP**: criteria specific to "stern ramp launch and recovery of small craft"

6.2 Criteria

6.2.1 Stern and davit (or side) launch and recovery

Criteria for stern and davit (or side) launch and recovery of small craft are provided in Tab 16.

6.2.2 Stern ramp launch and recovery

Criteria for stern ramp launch and recovery of small craft are provided in Tab 16 and Tab 17.

Table 16 : Criteria for launch and recovery of small craft

Ship response	Limit	Location
Pitch	1,25°	
Roll	4°	
Vertical acceleration	0,1g	At launch and recovery station on mothership
Lateral acceleration	0,1g	At launch and recovery station on mothership
Note 1: All limits given as RMS amplitude values.		

Table 17 : Additional criteria for stern ramp launch and recovery of small craft

Parameter	Limit	Location
Vertical wave height	0,75m	At ramp entrance
Lateral displacement	0,75m	At stern
Ramp availability time	Average 8 seconds	
Note 1: Relative wave height and lateral displacement limits are given in terms of RMS amplitude. **Note 2:** For relative wave height, if it is not possible to accurately estimate this parameter due to the absence of modelled radiated and diffracted waves, the criteria may instead be applied to vertical motion calculated at the stern.		

CHAPTER 10
SAFETY EQUIPMENT AND INSTALLATIONS

Section 1 Life-Saving Appliances (LSA)

1 General

1.1 Application

1.1.1 The additional class notation **LSA** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.13.1], to ships fitted with life-saving appliances and complying with the requirements of this Section.

1.2 Documents to be submitted

1.2.1 The documents listed in Tab 1 are to be submitted.

Table 1 : Documents to be submitted

No.	A/I**(1)**	Document
1	A	Safety Equipment Plan showing position and quantity of all life-saving equipment on board
2	I	Arrangement of life-saving appliances and relevant embarking and launching devices
3	A	Structure drawings with details of the hull/launching appliances interface
4	A	Calculations of the local structural reinforcements in way of the launching appliances
(1) A: to be submitted for approval; I: to be submitted for information		

1.3 Definitions

1.3.1 For the purpose of this additional class notation, unless expressly provided otherwise, definitions are as stated in SOLAS Convention Chapter III Regulation 3.

1.3.2 IMO LSA Code means the International Life-Saving Appliance (LSA) Code adopted by IMO Maritime Safety Committee by resolution MSC.48(66), as amended.

1.3.3 MSC.81(70) means the IMO Resolution "Revised recommendation on testing of life-saving appliances", as amended.

1.4 Approval of appliances and equipment

1.4.1 Where the words "of an approved type" are indicated, the equipment is to meet the requirements of the IMO LSA Code and MSC.81(70) and is to be approved by the Society, unless otherwise agreed with the Naval Authority. Other recognized references covering design and testing found acceptable by the Naval Authority and by the Society may be used for approval.

1.4.2 Unless expressly provided otherwise in this section, all life-saving appliances are to comply with the applicable requirements of the IMO LSA Code and MSC.81(70).

1.5 Alternative design and arrangements

1.5.1 When alternative design or arrangements deviate from the prescriptive provisions of the present Section, an engineering analysis, evaluation and approval of the design and arrangements are to be carried out in accordance with SOLAS regulation III/38.

Note 1: Refer to IMO Circular MSC.1/Circ.1212/Rev.1 "Guidelines on alternative design and arrangements for SOLAS chapters II-1 and III".

2 Survival craft

2.1 Number and location

2.1.1 Each ship is to carry:

a) On each side of the ship, one or more survival craft of an approved type complying with section 4.2 of the IMO LSA Code.

   The aggregate capacity of these survival crafts is to be sufficient to accommodate not less than 125% of the total number of persons on board.

b) Additional survival craft to ensure that at least 110% capacity will remain available in the event that all the survival craft on either side within the longitudinal damage extension (Pt B, Ch 3, Sec 3, [2.4.2]) are lost or unserviceable.

2.1.2 As far as practicable, survival craft are to be equally distributed on both sides of the ship.

2.1.3 If the survival craft cannot be readily transferred for launching on either side of the ship (i.e. of a mass of more than 185 kg or not stowed in a position providing for easy side-to-side transfer), the total capacity available on each side is to be sufficient to accommodate all persons on board.

2.1.4 Where the survival craft are stowed in a position which is more than 100 m from the extreme end of the stem or stern, each ship is to carry in addition to the survival craft as provided in [2.1.1], a survival craft with a carrying capacity of not less than six persons stowed as far forward or aft, or one as far forward and another as far aft, as is reasonable and practicable. Such survival craft may be securely fastened so as to permit manual release and need not be of the type which can be launched from an approved launching device.

2.1.5 A marine evacuation system (MES) or equivalent system complying with section 6.2 of the IMO LSA Code and associated liferafts complying with the requirements of paragraph 6.2.3 of the IMO LSA Code may be substituted for the equivalent capacity of survival craft required by [2.1.1].

2.2 Survival craft assembly and embarkation arrangements

2.2.1 Survival craft embarkation arrangements are to be so designed that:

a) davit-launched survival craft can be boarded and launched from a position immediately adjacent to the stowed position or from a position to which the survival craft is transferred prior to launching in compliance with [2.4.5], and
b) where necessary, means are to be provided for bringing the survival craft against the ship's side and holding it alongside so that persons can be safely embarked.

2.2.2 A MES complying with section 6.2 of the IMO LSA Code or an embarkation ladder complying with the requirements of paragraph 6.1.6 of the IMO LSA Code extending, in a single length, from the deck to the waterline in the lightest seagoing condition under maximum anticipated adverse list and trim for intact and damaged conditions is to be provided at each launching station. However, the Society may permit such ladders to be replaced by approved devices to afford access to the survival craft when waterborne, provided that there is to be at least one embarkation ladder on each side of the ship. Other means of embarkation enabling descent to the water in a controlled manner may be permitted for the survival craft required by [2.1.4].

2.3 Launching stations

2.3.1 Launching stations are to be in such positions that survival craft and rescue boats can be launched clear of all obstructions having particular regard to clearance from the propeller and steeply overhanging portions of the hull. As far as possible, survival crafts are to be launched down a straight side of the ship.

2.3.2 Launching stations are to be located abaft the collision bulkhead in a sheltered position and, if positioned forward, special consideration is to be given to the strength of the launching appliance.

2.4 Stowage of survival craft

2.4.1 Each survival craft is to be stowed:

a) so that neither the survival craft nor its stowage arrangement will interfere with the operation of any other survival craft, rescue boat or MES at any other launching station;
b) in such a position that the survival craft in the embarkation position is not more than 18m above the waterline with the ship in its lightest seagoing condition. Survival craft other than those intended for throw-overboard launching are to be stowed in a position such that the survival craft in the embarkation position is not less than 2 m above the waterline with the ship in the fully loaded condition under maximum anticipated adverse list or trim for damaged conditions, or to the angle at which the ship's weather deck edge becomes submerged, whichever is less;
c) as far as practicable, in a secure and sheltered position and protected from damage by fire and explosion not induced by hostile military action. In particular, survival craft, other than those required by [2.1.4], are not to be stowed near tanks or areas containing explosive or hazardous cargoes (Example: jettisonable fuel tanks or area of battery room ventilation);
d) fully equipped as required by the IMO LSA Code.

2.4.2 Survival craft for lowering down the ship's side are to be stowed as far forward of the propeller as practicable.

2.4.3 Every survival craft other than those mentioned in [2.1.4] are to be stowed with its painter permanently attached to the ship and with a float-free arrangement complying with the requirements of paragraph 4.1.6 of the IMO LSA Code so that each floats free and, if inflatable, inflates automatically when the ship sinks (i.e. automatic launching and inflating devices to be provided).

2.4.4 Survival craft are to be so stowed as to permit manual release of one raft or container at a time from their securing arrangements.

2.4.5 Davit-launched survival craft are to be stowed within reach of the lifting hooks, unless some means of transfer is provided which is not rendered inoperable within the limits of trim and list prescribed in Pt C, Ch 1, Sec 1, [2.4.1] for any damaged condition or by ship motion or power failure.

2.5 Survival craft launching and recovery arrangements

2.5.1 Launching appliances complying with the requirements of section 6.1 of the IMO LSA Code, as applicable, are to be provided for all davit-launched survival craft.

2.5.2 Launching arrangements are to be such that the appliance operator on the ship is able to observe the survival craft at all times during launching.

2.5.3 Only one type of release mechanism is to be used for similar survival craft carried on board the ship.

2.5.4 Preparation and handling of survival craft at any one launching station are not to interfere with the prompt preparation and handling of any other survival craft, rescue boat or MES at any other station.

2.5.5 Falls, where used, are to be long enough for the survival craft to reach the water with the ship in its lightest seagoing condition, under maximum anticipated adverse list and trim for intact and damaged conditions.

2.5.6 Means are to be available to prevent any discharge of water onto survival craft during abandonment.

2.5.7 All survival craft required to provide for abandonment by the total number of persons on board are to be capable of being launched with their full complement of persons and equipment within a period of 10 min from the time the abandon ship signal is given.

2.5.8 Launching and embarkation arrangements are to be so arranged as to enable stretcher cases to be placed in survival craft.

2.6 Stowage of marine evacuation systems

2.6.1 The ship's side is not to have any openings between the embarkation station of the marine evacuation system and the waterline in the lightest seagoing condition and means are to be provided to protect the system from any projections. The windows and side scuttles in the area in way of a marine evacuation system, if installed, are to be of the non-opening type.

2.6.2 Marine evacuation systems are to be in such positions as to ensure safe launching having particular regard to clearance from the propeller and steeply overhanging portions of the hull and so that, as far as practicable, the system can be launched down the straight side of the ship.

2.6.3 Each marine evacuation system is to be stowed so that neither the passage nor platform nor its stowage or operational arrangements will interfere with the operation of any other life-saving appliance at any other launching station.

2.6.4 Where appropriate, the ship is to be so arranged that the marine evacuation systems in their stowed positions are protected from damage by heavy seas.

3 Rescue boats

3.1 Number of rescue boats

3.1.1 Each ship is to carry at least one rescue boat complying with the requirements of section 5.1 of the IMO LSA Code.

3.2 Operational craft used as a rescue boat

3.2.1 Subject to acceptance of the Naval Authority, an operational craft may be accepted to replace the rescue boat and provide its function, provided that it is complying with the requirements of section 5.1 of the IMO LSA Code and with additional requirements for fast rescue boats, except that:

a) operational craft do not need to be fitted with retro-reflective material as required by paragraph 1.2.2.7 of the IMO LSA Code;
b) operational craft do not need to comply with paragraph 1.2.2.6 of the IMO LSA Code but are to be fitted with removable covers of orange colour (or equivalent highly visible colour) to increase visual detection. Such covers are to be fitted with retro-reflective material complying with paragraph 1.2.2.7 of the IMO LSA Code;
c) the length of operational craft may be above 8,5m limit given by paragraph 5.1.1.3 of the IMO LSA Code;
d) the radar reflector as required by paragraph 5.1.2.2.12 of the IMO LSA Code may be removable.

3.2.2 When operational craft are used as rescue boats, the following conditions are to be met:

a) sufficient number of operational craft are to be available in all operational scenarios;
b) sufficient number of operational craft are to be available to marshal all deployed survival craft that are not self-propelled;
c) means for rapidly recovering survivors from the water and transferring survivors to the ship are to be provided.

Note 1: Refer to IMO MSC./Circ.810 “Recommendation on means of rescue on Ro-Ro passenger ships”

3.2.3 The launching and recovery arrangements of the operational craft are to be also compliant with the requirements for a rescue boat as defined in [3.4].

3.3 Stowage of rescue boats

3.3.1 Rescue boats are to be stowed:

a) in a state of continuous readiness for launching in not more than 5 min

b) if of an inflated type, in a fully inflated condition at all times

c) in a position suitable for launching and recovery

d) so that neither the rescue boat nor its stowage arrangements will interfere with the operation of any survival craft at any other launching station.

3.4 Rescue boat embarkation, launching and recovery

3.4.1 Launching arrangements are to comply with the requirements of [2.5]. All rescue boats are to be capable of being launched, where necessary utilizing painters, with the ship making headway at speed up to 5 knots in calm water.

3.4.2 Recovery time of the rescue boat is to be not more than 5 minutes in moderate sea conditions when loaded with its full complement of persons and equipment.

3.4.3 Foul weather recovery strops are to be provided for safety if heavy fall blocks constitute a danger.

3.4.4 When the launching appliance of the rescue boat is fitted with a system to block radar detection or to protect the launching appliance, such system is to be operated manually or with a stored mechanical power device which is independent of the ship's power supplies to allow the launching of the rescue boat it serves in the fully loaded and equipped condition and also in the light condition.

4 Personal life-saving appliances

4.1 Lifebuoys

4.1.1 Total number

At least eight lifebuoys of an approved type, complying with paragraph 2.1.1 of the IMO LSA Code and located as per [4.1.3], are to be fitted. For ships of 100 m length or more, this number is to be increased up to the values given in Tab 2.

Table 2 : Lifebuoys

Length of ship (m)	Minimum number of lifebuoys
< 100	8
100 ≤ L < 150	10
150 ≤ L < 200	12
≥ 200	14

4.1.2 Types

a) Lifebuoys with buoyant lifeline:

At least one lifebuoy on each side of the ship is to be fitted with a buoyant lifeline complying with the requirements of paragraph 2.1.4 of the IMO LSA Code of length not less than twice the height at which it is stowed above the waterline in the lightest seagoing condition, or 30 m, whichever is greater.

b) Lifebuoys with self-igniting lights:

At least one-half of the total number of lifebuoys are to be provided with self-igniting lights complying with the requirements of paragraph 2.1.2. of the IMO LSA Code. Not less than two of these are to be also provided with self-activating smoke signals complying with the requirements of paragraph 2.1.3. of the IMO LSA Code. They are not to be the lifebuoys provided with lifelines in compliance with the requirements of item a).

4.1.3 Location

Lifebuoys are to be readily accessible from exposed locations on both sides of the ship with at least one placed in the vicinity of the stern. They are to be so stowed as to be capable of being cast loose and not permanently secured in any way.

Lifebuoys with lights and those with lights and smoke signals are to be equally distributed on both sides of the ship.

Lifebuoys fitted with self-igniting lights or self-activating smoke signals are to be located outside hazardous areas and be capable of quick release from the bridge or a location readily available to operating personnel.

4.2 Lifejackets

4.2.1 Lifejackets of an approved type complying with the requirements of section 2.2 of the IMO LSA Code are to be provided for at least 110% of the total number of persons on board.

4.2.2 Additionally, a sufficient number of lifejackets are to be carried for persons on watch and for use at remotely located survival craft stations. These lifejackets are to be stowed on the bridge, in the engine control room and at any other manned watch station.

4.2.3 Each lifejacket is to be fitted with a light complying with the requirements of paragraph 2.2.3 of the IMO LSA Code.

4.2.4 Each lifejacket is to be so placed as to be readily accessible and their position is to be plainly indicated.

4.3 Immersion suits and thermal protective aids

4.3.1 For ships carrying less than 60 persons on board, immersion suits of an approved type complying with the requirements of section 2.3 of the IMO LSA Code are to be provided for at least 110% of the total number of persons on board. Immersion suits are to be of an appropriate size for each person on board.

4.3.2 For ships carrying not less than 60 persons on board, a thermal protective aid complying with the requirements of section 2.5 of the IMO LSA Code is to be provided for every person to be accommodated in the survival craft and not provided with an immersion suit.

4.3.3 Each immersion suit is to be so placed as to be readily accessible and their position is to be plainly indicated.

4.3.4 Additionally, an immersion suit or an anti-exposure suit complying respectively with requirements of section 2.3 or 2.4 of the IMO LSA Code, of an appropriate size, is to be provided for every person assigned to crew the rescue boat or assigned to a marine evacuation system party.

5 Rescue arrangements

5.1 Line-throwing appliances

5.1.1 A line-throwing appliance complying with the requirements of section 7.1 of the IMO LSA Code is to be provided.

5.2 Communications

5.2.1 Two-way VHF radiotelephone apparatus

At least three two-way VHF radiotelephone apparatus are to be provided on each ship.

Such apparatus is to be approved according to IMO Resolution A.809(19) as amended by MSC.149(77), Performance standards for survival craft two-way VHF radiotelephone apparatus.

5.2.2 Search and rescue locating device

At least one search and rescue locating device is to be carried on each side of the ship. Such devices are to be stowed in such locations that they can be rapidly placed in any survival craft. Search and rescue locating devices are to be approved according to IMO Resolution A.802(19) as amended by MSC.247(83), Recommendation on performance standards for survival craft radar transponders for use in search and rescue operations and IMO Resolution MSC.246(83), Recommendation on performance standards for survival craft AIS search and rescue transmitters (AIS-SART) for use in search and rescue operations.

5.3 Distress flares

5.3.1 Not less than twelve rocket parachute flares, complying with the requirements of section 3.1 of the IMO LSA Code, are to be carried and be stowed on or near the navigation bridge.

Section 2 Towing (TOW)

1 Emergency towing arrangements

1.1 Definitions

1.1.1 Deadweight

Deadweight is the difference, in t, between the displacement of a ship in water of a specific gravity of 1,025 t/m^3 at the load waterline corresponding to the assigned summer freeboard and the lightweight of the ship (as defined in Pt B, Ch 1, Sec 2, [5.5.1].

1.2 Application

1.2.1 The requirements of this Article apply to equipment arrangement for towing ships out of danger in emergencies such as complete mechanical breakdowns, loss of power or loss of steering capability.

1.2.2 An emergency towing arrangement is to be fitted at the bow.

1.3 Documentation

1.3.1 Documentation for approval

In addition to the documents in Pt B, Ch 1, Sec 3, the following documentation is to be submitted to the Society for approval:

- general layout of the bow towing arrangement and associated equipment
- operation manual for the bow towing arrangement
- construction drawings of the bow strongpoints (towing brackets or chain cable stoppers) and fairleads (towing chocks), together with material specifications and relevant calculations
- drawings of the local ship structures supporting the loads applied by strongpoints, fairleads and roller pedestals.

1.3.2 Documentation for information

The following documentation is to be submitted to the Society for information (see Pt B, Ch 1, Sec 3):

- specifications of chafing gears, towing pennants, pick-up gears and roller fairleads
- deadweight, in t, of the ship at summer load line.

1.4 General

1.4.1 Scope

The emergency towing arrangements are to be so designed as to facilitate salvage and emergency towing operations on the concerned ship, primarily to reduce the risk of pollution.

1.4.2 Main characteristics

The emergency towing arrangements are, at all times, to be capable of rapid deployment in the absence of main power on the ship to be towed and easy connection to the towing ship.

To demonstrate such rapid and easy deployment, the emergency towing arrangements are to comply with the requirements in [1.12].

1.4.3 Typical layout

Fig 1 shows an emergency towing arrangement which may be used as reference.

1.4.4 List of major components

The major components of the towing arrangements, their position on board and the requirements of this Article which they are to comply with are defined in Tab 1.

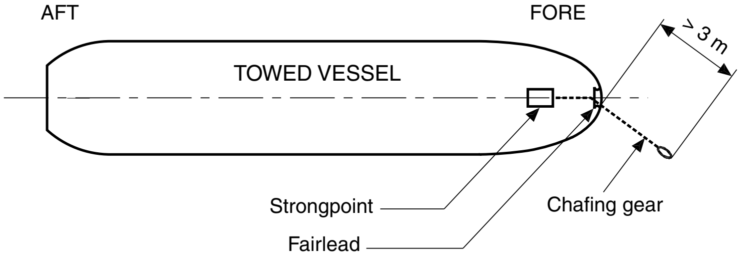
Table 1 : Major components of the emergency towing arrangement

Towing component	Forward	Reference of applicable requirements
Towing pennant	optional	[1.7]
Chafing gear	required	[1.8]
Fairlead	required	[1.9]
Strongpoint (inboard end fastening of the towing gear)	required	[1.10]
Pick-up gear	optional	no requirement
Pedestal roller fairlead	required	no requirement

1.4.5 Inspection and maintenance

All the emergency towing arrangement components are to be inspected by ship personnel at regular intervals and maintained in good working order.

Figure 1 : Typical emergency towing arrangement



1.5 Emergency towing arrangement approval

1.5.1 General

Emergency towing arrangements of ships are to comply with the following requirements:

- they are to comply with the requirements of this item
- they are to be type approved according to the requirements in [1.13]
- Certificates of inspection of materials and equipment are to be provided according to [1.13.2]
- fitting on board of the emergency towing arrangements is to be witnessed by a Surveyor of the Society and a relevant Certificate is to be issued
- demonstration of the rapid deployment according to the criteria in [1.12] is to be effected for each ship and this is to be reported in the above Certificate.

1.5.2 Alternative to testing the rapid deployment for each ship

At the request of the Owner, the testing of the rapid deployment for each ship according to [1.5.1] may be waived provided that:

- the design of emergency towing arrangements of the considered ship is identical to the type approved arrangements and this is confirmed by the on board inspection required in [1.5.1]
- the strongpoints (chain stoppers, towing brackets or equivalent fittings) are type approved (prototype tested).

In this case, an exemption certificate is to be issued.

In general, such dispensation may be granted to subsequent ships of a series of identical new buildings fitted with identical arrangements.

1.6 Safe working load (SWL) of towing pennants, chafing gears, fairleads and strongpoints

1.6.1 Safe working load

The safe working load (defined as one half of the ultimate strength) of towing pennants, chafing gear, fairleads and strongpoints is to be not less than that obtained, in kN, from Tab 2.

The strength of towing pennants, chafing gear, fairleads and strongpoints is to be sufficient for all pulling angles of the towline, i.e. up to 90° from the ship's centreline to port and starboard and 30° vertical downwards.

The safe working load of other components is to be sufficient to withstand the load to which such components may be subjected during the towing operation.

Table 2 : Safe working load

Ship deadweight DWT, in t	Safe working load, in kN
DWT < 50000	1000
DWT ≥ 50000	2000

1.7 Towing pennant

1.7.1 Material

The towing pennant may be made of steel wire rope or synthetic fibre rope, which is to comply with the applicable requirements in NR216 Materials and Welding, Ch 4, Sec 1.

1.7.2 Length of towing pennant

The length ℓ_P of the towing pennant is to be not less than that obtained, in m, from the following formula:

$$\ell_P = 2\,H + 50$$

where:

H : Difference of height between the watertight deck and the waterline when ship is in ballast loading condition.

1.7.3 Minimum breaking strength of towing pennants when separate chafing gear is used

Where a separate chafing gear is used, the minimum breaking strength MBS_p of towing pennants, including their terminations, is to be not less than that obtained from the following formula:

$$MBS_P = 2\,\mu\,SWL$$

where:

μ : Coefficient that accounts for the possible loss in strength at eye terminations, to be taken not less than 1,1

SWL : Safe working load of the towing pennants, defined in [1.6.1].

1.7.4 Minimum breaking strength of towing pennants when no separate chafing gear is used

Where no separate chafing gear is used (i.e. where the towing pennant may chafe against the fairlead during towing operation), the minimum breaking strength of the towing pennants MBS_{PC} is to be not less than that obtained, in kN, from the following formula:

$$MBS_{PC} = \varphi\,MBS_P$$

where:

MBS_P : Minimum breaking strength, in kN, defined in [1.7.3]

φ : Coefficient to be taken equal to:

$$\varphi = \frac{2\sqrt{\rho}}{2\sqrt{\rho} - 1}$$

φ may be taken equal to 1,0 if tests carried out under a test load equal to twice the safe working load defined in [1.6.1] demonstrate that the strength of the towing pennants is satisfactory

ρ : Bending ratio (ratio between the minimum bearing surface diameter of the fairlead and the towing pennant diameter), to be taken not less than 7.

1.7.5 Towing pennant termination

For towing connection, the towing pennant is to have a hard eye-formed termination allowing connection to a standard shackle.

Socketed or ferrule-secured eye terminations of the towing pennant are to be type tested in order to demonstrate that their minimum breaking strength is not less than twice the safe working load defined in [1.6.1].

1.8 Chafing gear

1.8.1 General

Different solutions for the design of chafing gear may be used.

If a chafing chain is to be used, it is to have the characteristics defined in the following requirements.

1.8.2 Type

Chafing chains are to be stud link chains.

1.8.3 Material

In general, grade Q3 chain cables and associated accessories complying with the applicable requirements in NR216 Materials and Welding, Ch 4, Sec 1 are to be used.

1.8.4 Chafing chain length

The chafing chain is to be long enough to ensure that the towing pennant, or the towline, remains outside the fairlead during the towing operation. A chain extending from the strongpoint to a point at least 3 m beyond the fairlead complies with this requirement.

1.8.5 Minimum breaking strength

The minimum breaking strength of the stud link chafing chain and the associated links is to be not less than twice the safe working load defined in [1.6.1].

1.8.6 Diameter of the common links

The diameter of the common links of stud link chain cables is to be not less than:

- 52 mm for a safe working load, defined in [1.6.1], equal to 1000 kN
- 76 mm for a safe working load, defined in [1.6.1], equal to 2000 kN.

1.8.7 Chafing chain ends

One end of the chafing chain is to be suitable for connection to the strongpoint. Where a chain stopper is used, the inboard end of the chafing chain is to be efficiently secured in order to prevent any inadvertent loss of the chafing chain when operating the stopping device. Where the chafing chain is connected to a towing bracket, the corresponding chain end may be constructed as shown in Fig 2, but the inner dimension of the pear link may be taken as 5,30 d (instead of 5,75 d).

The other end of the chafing chain is to be fitted with a standard pear-shaped open link allowing connection to a standard bow shackle. A typical arrangement of this chain end is shown in Fig 2. Arrangements different than that shown in Fig 2 are considered by the Society on a case-by-case basis.

1.8.8 Storing

The chafing chain is to be stored and stowed in such a way that it can be rapidly connected to the strongpoint.

1.9 Fairleads

1.9.1 General

Fairleads are normally to be of a closed type (such as Panama chocks).

Fairleads are to have an opening large enough to pass the largest portion of the chafing gear, towing pennant or towline. The corners of the opening are to be suitably rounded.

Where the fairleads are designed to pass chafing chains, the openings are to be not less than 600mm in width and 450mm in height.

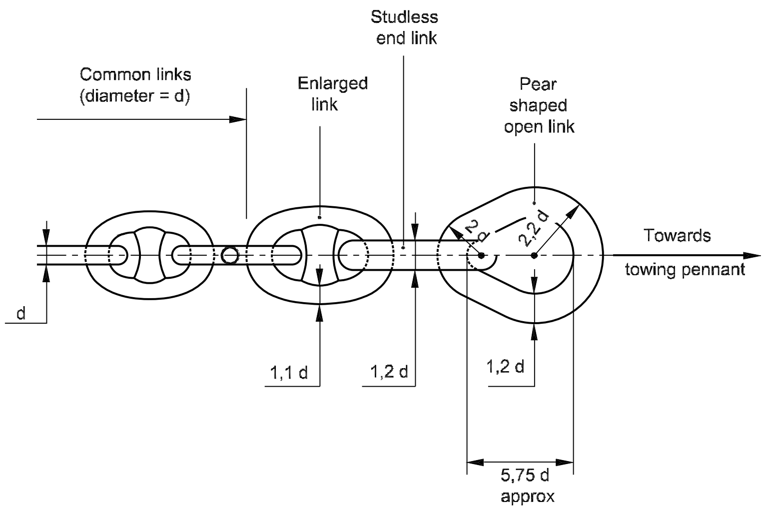
1.9.2 Material

Fairleads are to be made of fabricated steel plates or other ductile materials such as weldable forged or cast steel complying with the applicable requirements of NR216 Materials and Welding, Chapter 2.

1.9.3 Operating condition

The bow fairlead is to give adequate support for the towing pennant during towing operation, which means bending 90° to port and starboard side and 30° vertical downwards.

Figure 2 : Typical outboard chafing chain end



1.9.4 Positioning

The bow fairlead is to be located so as to facilitate towing from either side of the bow and minimise the stress on the towing system.

The bow fairlead is to be located as close as possible to the deck and, in any case, in such a position that the chafing chain is approximately parallel to the deck when it is under strain between the strongpoint and the fairlead.

Furthermore, the bow fairlead is normally to be located on the ship's centreline. Where it is practically impossible to fit the towing fairleads exactly on the ship’s centreline, it may be acceptable to have them slightly shifted from the centreline.

1.9.5 Bending ratio

The bending ratio (ratio between the towing pennant bearing surface diameter and the towing pennant diameter) is to be not less than 7.

1.9.6 Fairlead lips

The lips of the fairlead are to be suitably faired in order to prevent the chafing chain from fouling on the lower lip when deployed or during towing.

1.9.7 Yielding check

The equivalent Von Mises stress σ_E, in N/mm², induced in the fairlead by a load equal to the safe working load defined in [1.6.1], is to comply with the following formula:

$\sigma_E \leq \sigma_{ALL}$

Areas subjected to stress concentrations are considered by the Society on a case-by-case basis.

Where the fairleads are analysed through fine mesh finite element models, the allowable stress may be taken as 1,1 σ_{ALL}.

1.9.8 Alternative to the yielding check

The above yielding check may be waived provided that fairleads are tested with a test load equal to twice the safe working load defined in [1.6.1] and this test is witnessed by a Surveyor of the Society. In this case, the Designer is responsible for ensuring that the fairlead scantlings are sufficient to withstand such a test load.

Unless otherwise agreed by the Society, components subjected to this test load are considered as prototype items and are to be discarded.

1.10 Strongpoint

1.10.1 General

The strongpoint (inboard end fastening of the towing gear) is to be a chain cable stopper or a towing bracket or other fitting of equivalent strength and ease of connection. The strongpoint can be designed integral with the fairlead.

The strongpoint is to be type approved according to [1.13] and is to be clearly marked with its SWL.

1.10.2 Materials

The strongpoint is to be made of fabricated steel or other ductile materials such as forged or cast steel complying with the applicable requirements of NR216 Materials and Welding, Chapter 2.

Use of spheroidal graphite cast iron (SG iron) may be accepted for the main framing of the strongpoint provided that:

- the part concerned is not intended to be a component part of a welded assembly
- the SG iron is of ferritic structure with an elongation not less than 12%
- the yield stress at 0,2% is measured and certified
- the internal structure of the component is inspected by suitable non-destructive means.

The material used for the stopping device (pawl or hinged bar) of chain stoppers and for the connecting pin of towing brackets is to have mechanical properties not less than those of grade Q3 chain cables, defined in NR216 Materials and Welding, Ch 4, Sec 1.

1.10.3 Typical strongpoint arrangement

Typical arrangements of chain stoppers and towing brackets are shown in Fig 3, which may be used as reference.

Chain stoppers may be of the hinged bar type or pawl (tongue) type or of other equivalent design.

1.10.4 Position and operating condition

The operating conditions and the positions of the strongpoints are to comply with those defined in [1.9.3] and [1.9.4], respectively, for the fairleads.

1.10.5 Stopping device

The stopping device (chain engaging pawl or bar) is to be arranged, when in closed position, to prevent the chain stopper from working in the open position, in order to avoid chain cable release and allow it to pay out.

Stopping devices are to be easy and safe to operate and, in the open position, are to be properly secured.

1.10.6 Connecting pin of the towing bracket

The scantlings of the connecting pin of the towing bracket are to be not less than those of a pin of a grade Q3 end shackle, as shown in Fig 3, provided that clearance between the two side lugs of the bracket does not exceed 2,0d, where d is the chain diameter specified in [1.8.6] (see also Fig 2).

1.10.7 Yielding check

The equivalent Von Mises stress σ_E , in N/mm², induced in the strongpoint by a load equal to the safe working load defined in [1.6.1], is to comply with the following formula:

$\sigma_E \leq \sigma_{ALL}$

Areas subjected to stress concentrations are considered by the Society on a case-by-case basis.

Where the strongpoints are analysed through fine mesh finite element models, the allowable stress may be taken as 1,1 σ_{ALL}.

1.10.8 Alternative to the yielding check

The above yielding check may be waived provided that strongpoints are tested with a test load equal to twice the safe working load defined in [1.6.1] and this test is witnessed by a Surveyor. In this case, the Designer is responsible for ensuring that the fairlead scantlings are sufficient to withstand such a test load.

Unless otherwise agreed by the Society, components subjected to this test load are considered as prototype items and are to be discarded.

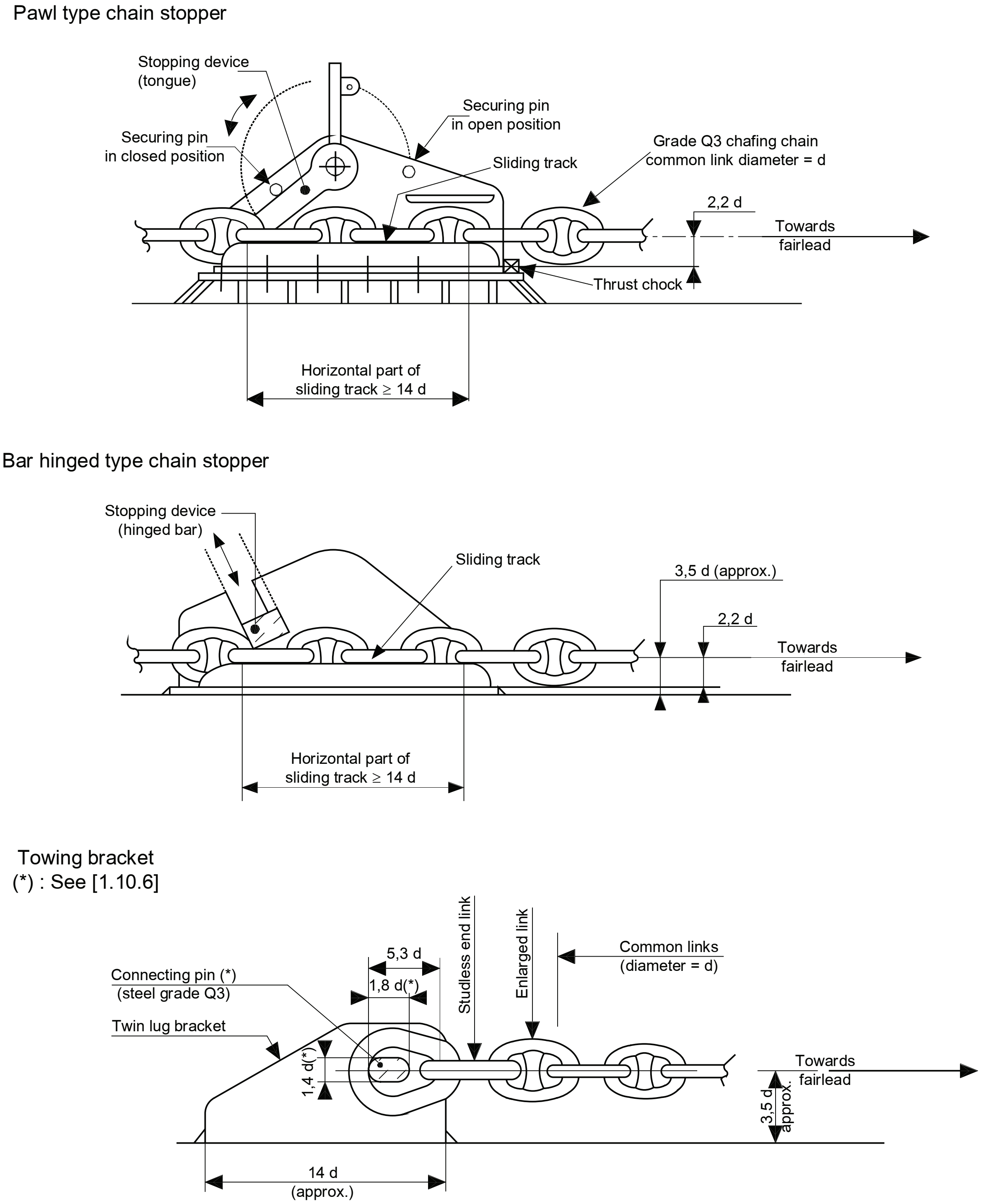
1.10.9 Bolted connection

Where a chain stopper or a towing bracket is bolted to a seating welded to the deck, the bolts are to be relieved from shear force by means of efficient thrust chocks capable of withstanding a horizontal force equal to 1,3 times the safe working load defined in [1.6.1] within the allowable stress defined in [1.10.7].

The steel quality of bolts is to be not less than grade 8.8 as defined by ISO standard No. 898/1.

Bolts are to be pre-stressed in compliance with appropriate standards and their tightening is to be suitably checked.

Figure 3 : Typical strongpoint arrangement



1.11 Hull structures in way of fairleads or strongpoints

1.11.1 Materials and welding

The materials used for the reinforcement of the hull structure in way of the fairleads or the strongpoints are to comply with the applicable requirements of NR216 Materials and Welding.

Main welds of the strongpoints with the hull structure are to be 100% inspected by adequate non-destructive tests.

1.11.2 Yielding check of bulwark and stays

The equivalent Von Mises stress σ_E , in N/mm^2, induced in the bulwark plating and stays in way of the fairleads by a load equal to the safe working load defined in [1.6.1], for the operating condition of the fairleads defined in [1.9.3], is to comply with the following formula:

$\sigma_E \leq \sigma_{ALL}$

1.11.3 Yielding check of deck structures

The equivalent Von Mises stress σ_E , in N/mm^2, induced in the deck structures in way of chain stoppers or towing brackets, including deck seatings and deck connections, by a horizontal load equal to 1,3 times the safe working load defined in [1.6.1], is to comply with the following formula:

$\sigma_E \leq \sigma_{ALL}$

1.11.4 Minimum gross thickness of deck plating

The gross thickness of the deck is to be not less than:

- 12 mm for a safe working load, defined in [1.6.1], equal to 1000 kN,
- 15 mm for a safe working load, defined in [1.6.1], equal to 2000 kN.

1.12 Rapid deployment of towing arrangement

1.12.1 General

To facilitate approval of towing arrangements and to ensure rapid deployment, emergency towing arrangements are to comply with the requirements of this item.

1.12.2 Marking

All components, including control devices, of the emergency towing arrangements are to be clearly marked to facilitate safe and effective use even in darkness and poor visibility.

1.12.3 Forward

The forward emergency towing arrangement is to be capable of being deployed in harbour conditions in not more than 1 hour.

The forward emergency towing arrangement is to be designed at least with a means of securing a towline to the chafing gear using a suitably positioned pedestal roller to facilitate connection of the towing pennant.

Forward emergency towing arrangements which comply with the requirements for aft emergency towing arrangements may be accepted.

1.13 Type approval

1.13.1 Type approval procedure

Emergency towing arrangements are to be type approved according to the following procedure:

- the arrangement design is to comply with the requirements of this Section
- each component of the towing arrangement is to be tested and its manufacturing is to be witnessed and certified by a Surveyor according to [1.13.2]
- prototype tests are to be carried out in compliance with [1.13.3].

1.13.2 Inspection and certification

The materials and equipment are to be inspected and certified as specified in Tab 3.

1.13.3 Prototype tests

Prototype tests are to be witnessed by a Surveyor and are to include the following:

- demonstration of the rapid deployment according to the criteria in [1.12]
- load test of the strongpoints (chain stoppers, towing brackets or equivalent fittings) under a proof load equal to 1,3 times the safe working load defined in [1.6.1].

A comprehensive test report duly endorsed by the Surveyor is to be submitted to the Society for review.

Table 3 : Material and equipment certification status

Component	Material		Equipment	
	Certificate	Reference of applicable requirements	Certificate	Reference of applicable requirements
Towing pennant	not applicable	[1.7.1]	C **(1)**	[1.7]
Chafing chain and associated accessories	C **(2)**	[1.8.3]	C **(1)**	[1.8]
Fairleads	W	[1.9.2]	C	[1.9]
Strongpoint: • main framing • stopping device	 C **(2)** C **(2)**	 [1.10.2] [1.10.2]	C **(3)**	[1.10]
Pick-up gear: • rope • buoy • line-throwing appliance	 not applicable not applicable not applicable	 – – –	 W not required **(4)** not required **(4)**	no requirement
Pedestal roller fairlead	W	–	not required **(4)**	no requirement

(1) according to NR216 Materials and Welding, Ch 10
(2) according to NR216 Materials and Welding, Chapter 2
(3) to be type approved.
(4) may be type approved.
Note 1:
C : indicates that a Society certificate is required
W : indicates that a manufacturer's document is required.

Section 3 Enhanced Fire Protection FIRE

1 General

1.1 Application

1.1.1 The additional class notation **FIRE** may be assigned, in accordance with Pt A, Ch 1, Sec 2, [6.14.6], to ships complying with the requirements of this section. The additional class notation **FIRE** is to be completed, between brackets, by one, or by a combination, of the following notations:

- **F**, for ships equipped with a sprinkler system in accordance with Article [2]
- **T**, for ships on which the low flame-spread characteristics of surface materials have been tested according to Article [3]
- **S**, for ships on which fire doors located on smoke extraction paths are planned to be kept open in accordance with Article [4].

1.2 Documents to be submitted

1.2.1 The documents to be submitted are listed in Tab 1.

Table 1 : Documentation to be submitted

No.	I/A **(1)**	Description
FIRE (**T**)		
1	A	Type approval certificates or specific test reports for low flame-spread characteristics of surface materials as per [3.2.1]
2	I	List of multilayer configurations to be tested or assessed and assessment methodology
FIRE (**S**)		
3	I	General arrangement drawing showing the fire doors required to be kept open for smoke evacuation purposes
(1) A: To be submitted for approval ; I: To be submitted for information		

2 Fire-fighting

2.1 Application

2.1.1 This article applies to ships to be assigned the additional class notation **FIRE** completed by **F**.

2.2 Accommodation spaces, service spaces and control stations

2.2.1 The ship is to be equipped with a sprinkler system of an approved type complying with the requirements of Pt C, Ch 4, Sec 14, [8] in all service spaces, control stations and accommodation spaces, including corridors and stairways.

3 Fire growth potential

3.1 Application

3.1.1 This article applies to ships to be assigned the additional class notation **FIRE** completed by **T**.

3.2 Low flame-spread testing

3.2.1 Specific tests are to be conducted for identified configurations involving multilayer construction in order to assess the low flame-spread characteristics of the surface materials listed in Pt C, Ch 4, Sec 2, [2.2.2], item d).

The list of multilayer configurations to be tested or assessed, assessment methodology and possible adjustments of acceptance criteria are to be agreed with the Naval Authority.

For each of the identified configurations, the low flame-spread characteristics of the considered surface materials are to be assessed for the layer combinations installed on board.

4 Smoke control

4.1 Application

4.1.1 This article applies to ships to be assigned the additional class notation **FIRE** completed by **S**.

4.1.2 The requirements of the present article apply to:

- fire doors in stairway and corridor bulkheads, except doors leading to cabins
- other fire doors required to be kept open for smoke evacuation purposes, as specified by the Naval Authority.

They do not apply to:

- doors leading to the open deck
- manually operated watertight doors
- power-operated watertight doors not subject to remote release
- manually operated watertight hatches.

4.2 Doors located on smoke evacuation paths

4.2.1 Fire doors listed in [4.1.2] are to be of a self-closing type and capable of remote-release from the continuously manned central damage control station. They are also to be capable of individual release from a position near the door.

4.2.2 Release switches are to have an on-off function to prevent automatic resetting of the system. Means of re-activation of the release switches is to be provided

- either for groups of doors corresponding to the smoke evacuation plan, independently of other fire doors, or
- for doors from a whole safety zone.

4.2.3 Hold-back hooks not subject to remote control in the continuously manned damage control station release are prohibited.

4.2.4 Indication is to be provided at the fire door indicator panel in the continuously manned damage control station whether the door is opened or closed.

Part E
Additional Class Notations

CHAPTER 11
OTHER NOTATIONS

Section 1 In-Water Survey Arrangements (INWATERSURVEY)

1 General

1.1 Application

1.1.1 The additional class notation **INWATERSURVEY** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.15.1].

1.2 Documentation to be submitted

1.2.1 Plans

Detailed plans of the hull and hull attachments below the waterline are to be submitted to the Society for approval. These plans are to indicate the location and/or the general arrangement of:

- all shell openings
- stem
- rudder and fittings
- sternpost
- propeller, including the means used for identifying each blade
- anodes, if any, including securing arrangements
- bilge keels
- welded seams and butts.

The plans are also to include the necessary instructions to facilitate the divers' work, especially for taking clearance measurements.

Moreover, a specific detailed plan showing the systems to be adopted in order to assess, when the ship is floating, the slack between pintles and gudgeons is to be submitted to the Society for approval.

1.2.2 Photographs

As far as practicable, a photographic documentation, used as a reference during the in-water surveys, of the following hull parts is to be submitted to the Society:

- propeller boss
- rudder pintles, where slack is measured
- typical connections to the sea
- directional propellers, if any
- other details, as deemed necessary by the Society on a case by case basis.

1.2.3 Documentation to be put on board

The Owner is to put on board of the ship the plans and documents given in [1.2.1] and [1.2.2] and they are to be made available to the Surveyor and the divers when an in-water survey is carried out.

2 Structure design principles

2.1

2.1.1 Identification system

Identification system such as Ariadne thread, or any other systems accepted by the Society which permit to locate the diver under the hull of the ship is to be supplied to facilitate the in-water survey.

2.1.2 Rudder arrangements

Rudder arrangements are to be such that rudder pintle clearances and fastening arrangements can be checked as far as practicable.

2.1.3 Tailshaft arrangements

Tailshaft arrangements are to be such that clearances (or wear by poker gauge) can be checked as far as practicable.

Section 2 Helicopter Deck (HELICOPTER)

1 General

1.1 Application

1.1.1 Ships complying with the requirements of this Chapter are eligible for the assignment of the additional class notation **HELICOPTER**, as defined in Pt A, Ch 1, Sec 2, [6.15.2].

1.1.2 Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C and D of the Rules, as applicable and with the requirements of this Chapter, which are specific to helideck.

2 Structure

2.1

2.1.1 For ships with the additional class notation **HELICOPTER**, the helicopter loads, as specified in this Article, are to be provided for information.

2.1.2 Design loads

a) In general, the design loads are to be calculated as specified in items c) or d), as applicable depending on the service notation assigned to the ship.

b) Other loads are to be considered when deemed necessary by the Society, depending on the operation that will be carried out on the ships (e.g. the loads induced by the helicopter engine test operations). In these cases, the design loads are to be provided by the Designer.

c) The loads transmitted by the helicopter to helideck structures are to be calculated according to Pt B, Ch 8, Sec 11, [5].

d) The still water loads transmitted by the helicopter to helideck structures, namely the landing and parking loads transmitted through the helicopter tyres, are to be provided by the Designer.

e) The inertial forces induced by ship motion and acceleration are to be calculated, on the basis of the above still water loads, according to Pt B, Ch 5, Sec 6.

2.1.3 Hull scantlings

In general, the helideck structures are to be checked according to Part B, Chapter 7, considering the design local loads and their combination with the hull girder loads as specified in the above Chapter.

2.1.4 Documents to be submitted

The documents listed in Tab 1 items 1 and 2 are to be submitted.

3 Fire protection, detection and extinction

3.1 General

3.1.1 The provisions of this Article are in addition of those given in Pt C, Ch 4, Sec 10.

3.1.2 The documents listed in Tab 1 are to be submitted.

3.1.3 Nozzles and rescue equipment

When not required by Pt C, Ch 4, Sec 10, [3.1.1], at least two nozzles of an approved type (jet/spray) each fed by two hose lengths complying with Pt C, Ch 4, Sec 6, [1.2.5] and Pt C, Ch 4, Sec 6, [1.4.3] shall be capable to reach any part of flying-deck.

All fire stations relevant to helideck shall be capable to delivery water or low expansion foam.

Table 1 : Documents to be submitted

No.	I/A **(1)**	Documents **(2)** **(3)**
1	A	Drawings of helideck structural arrangements and scantlings
2	I	Details on the loads calculations
3	I	General plans shown the position of ship's spaces and helideck, refuelling and de-refuelling stations and JP5-NATO(F44) pump rooms, helicopter and aircraft positions, take off areas, landing areas, as well as spaces dedicated to fire-extinguishing units (as applicable)
4	A	Diagram of thick water fire-extinguishing systems for helideck
5	A	Diagram of twin media fire-extinguishing system for helideck including pressure containers
6	A	Diagram of JP5-NATO(F44) pump room fire-extinguishing systems (as applicable)
7	A	Plan(s) of fire appliances for helideck as well as refuelling and de-refuelling stations and drainage facilities (as applicable)

(1) A = to be submitted for approval
I = to be submitted for information.
(2) Diagram are also to include, where applicable, the (local and remote) control and monitoring systems and automation systems
(3) Diagrams are to be schematic and functional and have to contain all information necessary for their correct understanding and verification

3.2 Additional fire safety measures for helideck

3.2.1 General

The helideck shall be provided with the following fire-fighting appliances from item a) to e) or from item f) to i):

a) in substitution to the requirements of Pt C, Ch 4, Sec 10, [3.1.1], item d), at least one semi-portable carbon dioxide extinguisher having capacity of at least 18 kg with necessary fittings to direct the carbon dioxide to the engine of helicopter when in the take off position; and

b) at least one semi-portable foam fire extinguisher of at least 45 l capacity with necessary fittings to direct the foam on deck area of crashed helicopter; and

c) a thick water helideck system; and

d) in substitution to the requirements of Pt C, Ch 4, Sec 10, [3.1.1], items a), b) and c), a twin media helideck system; and

e) in substitution to the requirements of Pt C, Ch 4, Sec 10, [3.1.1], items a), b) and c), at least two autonomous mobile twin media applicators; or

f) in substitution to the requirements of Pt C, Ch 4, Sec 10, [3.1.1], item d), at least one semi-portable carbon dioxide extinguisher having capacity of at least 18 kg with necessary fittings to direct the carbon dioxide to the engine of helicopter when in the take off position; and

g) at least two semi-portable foam fire-extinguishers of at least 45 l capacity with necessary fittings to direct the foam on deck area of crashed helicopter; and

h) a thick water system complying with the requirements of [3.2.2] for the protection of the door of the hangar only. This system is not required to provide continuous and complete coverage of the helideck with thick water; and

i) in substitution to the requirements of Pt C, Ch 4, Sec 10, [3.1.1], items a), b) and c), a twin media helideck system complying with the requirements of [3.2.3]. In addition, the monitors shall be capable of delivery the two media on any part of the helideck. The supply rate of the foam shall be not less than 5 l/min/m2 during at least 10 min discharge time. In any case, each monitor shall be capable of delivering foam at a supply rate of at least 2000 l/min during at least 10 min discharge time.

3.2.2 Thick water helideck system

a) The thick water helideck system shall provide continuous and complete coverage of the helideck and the door of the hangar with thick water.

b) The thick water is composed by sea water mixed with at least 3% of a type approved AFFF emulsifier (Agent Forming a Floating Film). The Society may authorize a lower concentration if the emulsifier media efficiency and the correct working of the system with lower concentrations are demonstrated.

c) The thick water shall be generated by generators units which shall include emulsifier container with a gauging system, proportioning mixer connected to the fire main.

d) Means shall be provided for washing the system with fresh water after use.

e) The nozzles provided for the system may be fitted directly on the helideck.

f) The system shall be capable of delivery thick water at a rate of not less than 5 l/m²/min during not less than 5 minutes operation time.

g) The helideck thick water system may be divided into sections which shall be fed by the relevant sections of the fire main.

h) The system section valves and connection valves with the fire main shall be monitored from the damage control station. Such valves shall be located outside the protected area. The remote operation of such valves shall be possible from the control room of the helicopter operations. Local operation of the section valves shall be also possible.

i) For ships to be assigned the **CBRN** additional class notation, the thick water helideck system may be combined with the pre-wetting and washdown system provided for CBRN protection, if provided in accordance with Ch 8, Sec 3, [4], on the condition that the provisions for both systems are complied with.

3.2.3 Twin media helideck system

a) The two media shall be dry chemical powder, and foam solution. The powder and the foam forming liquid shall be of a type approved by the Society.

b) The two media shall be stored in pressure vessels which shall be pressurized by pressure air in dedicated pressurized bottles.

c) In addition the system shall be provided with means of control, fixed media pressurizing piping and fixed media delivering pipes to monitors.

d) The two media shall be delivered by in pairs monitors capable of simultaneous operation. In any case there shall be fitted at least two monitors.

e) The system shall be capable of delivery the two media on any part of the parcking area for helicopter which has caught fire.

Note 1: The parking area of the helideck is the area contained within a circle of diameter “D”, where “D” is the distance in meters across the main rotor and the tail rotor in the fore and aft line of an helicopter with a single main rotor and across both rotors for a tandem rotor helicopter.

f) The monitor throw in still air conditions shall not be less than 1,3 times the maximum distance of the monitor from any point of the area intended to be protected by this monitor.

g) The discharge rate is to be as follow:

- not less than 10, 25 and 45 kg/s for the maximum coverage distance of 10, 30 and 40 meters for the powder delivery
- not less than 20 l/s for the foam delivery.

h) The quantity of chemical powder and foam solution in the system containers for shall be not less than the quantity required for 45 seconds discharge time for the powder and the foam. The container volume shall be that required for housing the medium and that of the gap necessary for the pressurization of the container with air.

i) The helideck shall be provided with the twin media units necessary to comply with the provisions items. Such units shall be positioned as not to interfere with the helicopter operations.

j) Monitors shall have features for manual and remote control laying as well as for media discharge operations.

k) The expansion ratio of the foam shall not exceed 12 to 1.

3.2.4 Autonomous mobile twin media applicators

a) The two media shall be dry chemical powder, and foam solution. The powder and the foam forming liquid shall be of a type approved by the Society.

b) The two media shall be stored in pressure vessels which shall be pressurized by pressure air in dedicated pressurized bottles.

c) In addition the system shall be provided with means of control, fixed media pressurizing piping and fixed media delivering pipes to applicator nozzles fitted with hand hose lines.

d) The two media shall delivered by in pairs of applicator nozzles capable of simultaneous operation.

e) The system shall be capable of delivery the two media on any part of the helideck.

f) The hand hose lines shall not exceed 33 meters in length.

g) The discharge rate is to be as follow :

- not less than 100 kg/min for the powder delivery
- not less than 200 l/min for the foam delivery.

h) The quantity of chemical powder and foam solution in the system containers for each applicator nozzle shall be not less than the quantity required for 1 minute discharge time for the powder media and 10 minutes for the foam media. The container volume shall be that required for housing the medium and that of the gap necessary for the pressurization of the container with air.

i) The helideck shall be provided with the twin media units necessary to comply with the provisions items. Such units shall be positioned as not to interfere with the helicopter operations.

j) Applicator nozzles fitted with hand hose lines shall have features for one man operation.

k) The expansion ratio of the foam shall not exceed 12 to 1.

Section 3 Refrigeration Installation (REF-STORE)

1 General

1.1 Application

1.1.1 The additional class notation **REF-STORE** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.9], to ships with refrigerating installations related to preservation of ship's domestic supplies, complying with the requirement of this Chapter.

1.1.2 The requirements of this Chapter apply to refrigerating installations on ships. These requirements are specific to permanently installed refrigerating installations and associated arrangements and are to be considered additional to those specified in Pt C, Ch 1, Sec 14, which are mandatory for all ships with refrigerating installations.

1.2 Definitions

1.2.1 Direct cooling system

Direct cooling system is the system by which the refrigeration is obtained by direct expansion of the refrigerant in coils fitted on the walls and ceilings of the refrigerated chambers.

1.2.2 Indirect cooling system

Indirect cooling system is the system by which the refrigeration is obtained by brine or other secondary refrigerant, which is refrigerated by a primary refrigerant, circulated through pipe grids or coils fitted on the walls and ceilings of the refrigerated chambers.

1.2.3 Refrigerant

Refrigerant is a cooling medium which is used to transmit and maintain the cool in the refrigerated chamber.

1.2.4 Brine

Brine is a refrigerant constituted by a solution of industrial salts, which is normally used to cool the chambers in the indirect cooling systems, as secondary refrigerant. In general, in this Chapter, the word brine is also used to cover other types of secondary refrigerants, as for instance refrigerants based on glycol.

1.2.5 Refrigerating unit

A refrigerating unit includes one or more compressors driven by one or more prime movers, one condenser and all the associated ancillary equipment necessary to form an independent gas-liquid system capable of cooling refrigerated chambers.

When the installation includes a secondary refrigerant (brine), the refrigerating unit is also to include a brine cooler (evaporator) and a pump.

1.2.6 Refrigerated chamber

A Chamber may be a ship's store space or any other ship service space for preservation or de-freezing of ship's domestic victuals.

2 Design criteria

2.1 Reference conditions

2.1.1 Design arrangements and temperature

The design arrangements of refrigerated and conditioned spaces for transport, preservation, de-freezing, processing, distribution of victuals, including incompatibility victuals preservation as well as appropriate space temperature to stowed victuals, are to comply with hygienic-healthful requirement of Naval Authority.

The refrigerating plants are to be designed according to temperatures requested by the Naval Authority and in accordance with the Administration requirements.

2.1.2 Environmental conditions

Unless otherwise indicated in the ship specification, the following environmental conditions are to be considered for the heat transfer and balance calculations and for the running rate of the refrigerating machinery:

- Sea water temperature: 32°C
- Outside air temperature: 35°C
- Relative humidity of air at 35°C: 80%.

For the determination of heat transfer through outside walls liable to be exposed to sun radiation, the outside air temperature is to be taken as equal to 45°C.

2.1.3 Operating conditions

The refrigerating plant inclusive of all machinery, equipment and accessories is to operate satisfactorily under the conditions indicated in Tab 1.

Table 1 : Operating conditions

Length of ship (m)		< 100	< 200	≤ 300	> 300
Permanent list		15°	15°	15°	15°
Roll		± 22,5°	± 22,5°	± 22,5°	± 22,5°
Pitch		± 10°	± 7,5°	± 5°	± 3°
Trim	Aft	5,0°	2,5°	1,5°	1,0°
	Forward	2,0°	1,0°	0,5°	0,3°

3 Documentation

3.1 Refrigerating installations

3.1.1 Plans to be submitted

The plans listed in Tab 2 are to be submitted as applicable.

The listed plans are to be constructional plans complete with all dimensions and are to contain full indication of types of materials employed.

Plans of equipment which are type approved by the Society need not be submitted, provided the types and model numbers are made available.

3.1.2 Calculations to be submitted

The calculations listed in Tab 3 are to be carried out in accordance with criteria agreed with the Society and are to be submitted.

Table 2 : Documents to be submitted

No.	A/I **(1)**	Document
1	I	Detailed specification of the plant (refrigerating machinery and insulation) including the reference design and ambient conditions
2	I	General arrangement of refrigerated spaces including: • the intended purpose of spaces adjacent to refrigerated spaces • the arrangement of air ducts passing through refrigerated spaces • the arrangement of steelwork located in refrigerated spaces or in insulated walls • the arrangement of the draining system • the individual volume and the total volume of the refrigerated spaces
3	A	Drawings showing the thickness and methods of fastening of insulation on all surfaces in refrigerated spaces, including: • insulation material specification • hatch covers • doors • steel framing (pillars, girders, deck beams) • bulkhead penetrations • etc.
4	A	Cooling appliances in refrigerated spaces (coil grids, air coolers with air ducts and fans, etc.)
5	I	Characteristic curves of fans (capacity, pressure, power consumption)
6	A	Distribution of the thermometers and description of remote thermometer installation, if any, including: • detailed description of the apparatus with indication of the method and instruments adopted, measuring range, degree of accuracy and data regarding the influence of temperature variations on connection cables • electrical diagram of apparatus, with indication of power sources installed, characteristics of connection cables and all data concerning circuit resistance • drawings of sensing elements and their protective coverings and indicators, with specification of type of connections used
7	A	General arrangement and functional drawings of piping (refrigerant system, brine system if any, sea water system, defrosting system, etc.)
8	I	Characteristic curves of circulating pumps for refrigerant or brine (capacity, pressure, power consumption, etc.)
9	I	General arrangement of refrigerating machinery spaces (main data regarding prime movers for compressors and pumps, including source of power, are to be included in this drawing)
10	A	Electrical wiring diagram

No.	A/I **(1)**	Document
11	A	Compressor main drawings (sections and crankshaft or rotors) with characteristic curves giving the refrigerating capacity
12	A	Drawings of main items of refrigerant system and pressure vessels, such as condensers, receivers, oil separators, evaporators, gas containers, etc.
13	A	Remote control, monitoring and alarm system (if any)
14	I	Operation manual for the refrigerating plant and for refrigerated containers, as applicable
(1) A = To be submitted for Approval, I = To be submitted for Information.		

Table 3 : Calculations to be submitted

No.	A/I **(1)**	Item
1	I	Detailed calculation of the heat balance of the plant. The calculation is to take into account the minimum internal temperatures for which the classification is requested and the most unfavourable foreseen ambient conditions.
(1) I = for Information.		

4 General technical requirements

4.1 Refrigeration of chambers

4.1.1 Refrigerating systems

Refrigeration of the chambers may be achieved by one of the following systems:

- direct cooling system
- air cooling system.

4.1.2 Cold distribution

a) The chambers may be refrigerated either by means of grids distributed on their walls or by means of air circulation on air coolers.

b) Grids and/or air coolers may be supplied either by brine or by a direct expansion system depending on the type of refrigerating system.

4.2 Refrigerating unit

4.2.1 Availability

The total refrigerating capacity of the plant is to be such as, in the most unfavourable conditions of external temperatures, it is possible to maintain, in the insulated spaces loaded with refrigerated goods, the temperature(s) for which the plant has been designed, with all refrigerating units, except one, working 24 h a day, if necessary.

4.3 Defrosting

4.3.1 Means are to be provided for defrosting air cooler coils, even when the refrigerated chambers are loaded to their maximum. Air coolers are to be fitted with trays and gutterways for gathering condensed water.

4.3.2 Arrangements are to be made to drain away the condensate even when the refrigerated chambers are loaded to their maximum. See [5.8] for specific requirements.

4.4 Prime movers and sources of power

4.4.1 Number of power sources

The motive power for each refrigerating unit is to be provided by at least two distinct sources. Each source is to be capable of ensuring the service of the plant under the conditions stated in [2.1.1], [2.1.2] and [2.1.3], without interfering with other essential services of the ship.

4.4.2 Electric motors

Where the prime movers of refrigerating units are electric motors, the electrical power is to be provided by at least two distinct generating sets.

4.5 Pumps

4.5.1 Minimum number of condenser pumps

a) At least one standby condenser circulating pump is to be provided; this pump is to be ready for use and its capacity is not to be less than that of the largest pump that it may be necessary to replace.

b) One of the condenser circulating pumps may be one of the ship's auxiliary pumps, provided its capacity is sufficient to serve the refrigerating plant working at maximum power without interfering with essential services of the ship.

4.5.2 Plants with intermediate cooling media

a) Where an intermediate cooling medium is used, at least one standby brine circulating pump is to be provided; this pump is to be ready for use and its capacity is not to be less than that of the largest pump that it may be necessary to replace.

b) The same provision applies to any other type of plants in which the circulation of refrigerant is ensured by pumps.

4.6 Sea connections

4.6.1 Number and location of sea connections

a) The cooling water is normally to be taken from the sea by means of at least two separate sea connections.

b) The sea connections for the refrigerating plant are to be distributed, as far as practicable, on both sides of the ship.

4.6.2 Connections to other plants

Where the circulating pump(s) of the refrigerating plant is/are connected to the same circuit as other pumps, precautions are to be taken in the design and arrangement of piping so that the working of one pump does not interfere with another.

4.7 Refrigerating unit spaces

4.7.1 Arrangement

Refrigerating machinery spaces are to be provided with efficient means of ventilation and drainage and, unless otherwise allowed by the Society, are to be separated from the refrigerated spaces by means of gas-tight bulkheads.

Ample space is to be provided around the refrigerating machinery to permit easy access for routine maintenance and to facilitate overhauls, particularly in the case of condensers and evaporators.

4.7.2 Dangerous refrigerants in machinery spaces

Use of dangerous refrigerants in machinery spaces may be permitted in accordance with Part C, Chapter 1.

5 Refrigerated chambers

5.1 Construction of refrigerated chambers

5.1.1 Bulkheads surrounding refrigerated chambers

a) Generally, the bulkheads of refrigerated chambers are to be of metallic construction; however, the bulkheads between two refrigerated spaces intended to contain goods of the same nature or having no contaminating effect need not be metallic.

b) The bulkheads are to be gas-tight.

c) Steels intended to be used for the construction of refrigerated chambers are to comply with the applicable provisions of Pt B, Ch 4, Sec 1 for low temperature steels.

5.1.2 Prefabricated chambers

Prefabricated chambers are to be of a robust construction, capable of withstanding the usual movements of a sea going vessel (vibration, inclination, acceleration, etc.).

They are to be fitted with suitable pressure equalising devices; these devices are to be so designed to allow the passage of air in either direction and remain closed in the absence of pressure differential.

The inner and outer surfaces of the prefabricated panels are to be covered with a suitable lining.

5.1.3 Closing devices

a) The closing devices of the accesses to refrigerated chambers, such as doors, hatch covers and plugs for loading or surveying are to be as far as possible gas-tight.

b) The ventilators of refrigerated chambers, if any, are to be fitted with gas-tight closing devices.

5.2 Penetrations

5.2.1 Penetration of pipes and ducts

Penetrations of pipes through watertight, gas-tight or fire-resistant decks and bulkheads are to be achieved by fitting glands suitable for maintaining the tightness and fire-resisting characteristics of the pierced structure.

5.2.2 Penetration of electrical cables

Where electrical wiring passes through refrigerated chambers, the relevant requirements of Part C, Chapter 2 are to be complied with.

5.3 Access to refrigerated spaces

5.3.1 Access doors to refrigerated chambers are to be provided with means of opening from inside even where they have been shut from outside.

5.3.2 A calling mean is to be installed inside the refrigerated chambers, in an accessible place on the lower part of one of the walls.

5.4 Insulation of refrigerated chambers

5.4.1 The insulation of refrigerated chambers shall comply with the following requirements:

a) The insulating material is to be non-hygroscopic. The insulating boards are to have satisfactory mechanical strength. Insulating materials and binders, if any, are to be odourless and so selected as not to absorb any of the odours of the goods contained in refrigerated chambers. The materials used for linings are to comply with the same provisions.

b) Polyurethane and other plastic foams used for insulation are to be of a self-extinguishing type according to a standard acceptable by the Society. In general, these foams are not to be used without a suitable protective coating.

c) The insulation together with its coating is normally to have low flame spread properties according to an accepted standard.

d) Plastic foams of a self-extinguishing type, suitably lined, may also be used for insulation of piping and air ducts.

e) When it is proposed to use foam prepared in situ, the detail of the process is to be submitted for examination before the beginning of the work.

f) Prefabricated panels are to be of a design such that, when erected, the continuity of the insulation is ensured.

Possible gaps are to be filled with insulation material.

5.5 Protection of insulation

5.5.1 Insulation extension

The insulation and the lining are to be carefully protected from all damage likely to be caused by the goods contained in the chamber or by their handling.

5.5.2 Insulation strength

The insulation lining and the air screens with their supports are to be of sufficient strength to withstand the loads due to the goods liable to be carried in the refrigerated chambers.

Insulation linings are to be constructed and fitted so that thay are airtight and provide an effective vapour barrier. The means of joining prefabricated panels are to have sufficient mechanical strength to maintain a vapour barrier on the inner and outer faces. All joints are to be sealed with a suitable gasket.

5.5.3 Removable panels

a) A sufficient number of removable panels are to be provided in the insulation, where necessary, to allow inspection of the bilges, bilge suctions, bases of pillars, vent and sounding pipes of tanks, tops of shaft tunnels and other structures and arrangements covered by the insulation.

b) Where the insulation is covered with a protective lining, certain panels of this lining are to be provided with a suitable number of inspection openings fitted with watertight means of closing.

5.6 Miscellaneous requirements

5.6.1 Refrigerated chambers adjacent to oil or fuel tanks

a) An air space of at least 50 mm is to be provided between the top of fuel and lubricating oil tanks and the insulation, so designed as to allow leaks to drain to the bilges. Such air space may be omitted provided multiple sheaths of an odourless oil-resisting material are applied to the upper surface of tank tops. The total required thickness of sheathing depends on the tank construction, on the composition used and on the method of application.

b) In general, the sides of fuel and lubricating oil tanks are to be separated from refrigerated spaces by means of cofferdams. The cofferdams are to be vented, the air vents fitted for this purpose are to be led to the open and their outlets are to be fitted with wire gauze which is easily removable for cleaning or renewal. The cofferdams may be omitted provided that multiple sheaths of an odourless oil-resisting material are applied on the tank side surface facing the refrigerated chambers. The total required thickness of this sheathing depends on the composition used and on the method of application.

5.6.2 Refrigerated chambers adjacent to high temperature spaces

The insulation of the walls adjacent to coalbunkers or to any space where an excessive temperature may arise, by accident or otherwise, is to be made of mineral wool or any equivalent material; wood chips, if any, are to be fireproof and separated from the plates on which they are fitted by means of insulating sheets.

5.6.3 Wooden structures

Wooden beams and stiffeners are to be insulated and strips of suitable insulating material are to be fitted between them and the metallic structures.

5.6.4 Metal fittings

All metal fittings (bolts, nuts, hooks, hangers, etc.) necessary for fitting of the insulation are to be galvanised or made in a corrosion-resistant material.

5.6.5 Equipment below the insulation

Arrangements are to be made whilst building in order to facilitate the examination in service of parts such as bilge suctions, scuppers, air and sounding pipes and electrical wiring which are within or hidden by the insulation.

5.7 Installation of the insulation

5.7.1 The following requirements shall be fulfilled:

a) Before laying the insulation, steel surfaces are to be suitably cleaned and covered with a protective coating of appropriate composition and thickness.

b) The thickness of the insulation on all surfaces together with the laying process are to be in accordance with the approved drawings.

c) The insulating materials are to be carefully and permanently installed; where they are of slab form, the joints are to be as tight as possible and the unavoidable crevices between slabs are to be filled with insulating material. Bitumen is not to be used for this purpose.

d) Joints of multiple layer insulations are to be staggered.

e) In applying the insulation to the metallic structures, any paths of heat leakage are to be carefully avoided.

5.8 Drainage of refrigerated spaces

5.8.1 General

All refrigerated spaces and trays under air coolers are to be fitted with means suitable for their continuous and efficient drainage.

5.8.2 Drain pipes

a) Drain pipes from refrigerating space cooler trays are to be fitted with liquid sealed traps provided with non-return valves which are easily accessible, even when the chamber is fully loaded.

b) Threaded plugs, blank flanges and similar means of closing of drain pipes from refrigerated spaces and trays of air coolers are not permitted.

c) Where means of closing of drain pipes are required by the Owner, these are to be easily checked and the controls are to be located in an accessible position on a deck above the maximum ship draft.

6 Refrigerants

6.1 General

6.1.1 Prohibited refrigerants

For restrictions on the selection of refrigerants, see Pt C, Ch 1, Sec 14, [2.2.1] and Pt C, Ch 1, Sec 14, [2.2.3].

6.2 Rated working pressures

6.2.1 Pressure parts design pressure

a) The refrigerant design pressure is not to be less than the maximum working pressure of the installation or its parts, either in operation or at rest, whichever is the greater. No safety valve is to be set at a pressure higher than the maximum working pressure.

b) In general, the design pressure of the low pressure side of the system is to be at least the saturated vapour pressure of the refrigerants at 40°C. Due regard is to be paid to the defrosting arrangement which may increase the pressure on the low pressure system.

c) The design pressure of the high pressure side of the installation is to be based on the condenser working pressure while it operates with water cooling in tropical zones. In general, the rated working pressure is to be taken not less than the effective saturated vapour pressure at 50°C.

6.2.2 In general, the design pressure for high and low pressure parts of refrigerating systems is to be taken not less than the values indicated in the manufacturer's documentation

7 Refrigerating machinery and equipment

7.1 Prime movers

7.1.1 General requirements

a) The diesel engines driving the compressors are to satisfy the relevant requirements of Pt C, Ch 1, Sec 2.

b) The electric motors driving the compressors, pumps or fans are to satisfy the relevant requirements of Pt C, Ch 2, Sec 4.

7.2 Common requirements for compressors

7.2.1 Casings

The casings of rotary compressors are to be designed for the design pressure of the high pressure side of the system indicated in line with [6.2].

7.2.2 Cooling

a) Air-cooled compressors are to be designed for an air temperature of 45°C.

b) For sea water cooling, a minimum inlet temperature of 32°C is to be applied. Unless provided with a free outlet, the cooling water spaces are to be protected against excessive overpressure by safety valves or rupture safety devices.

7.2.3 Safety devices

a) Stop valves are to be provided on the compressor suction and discharge sides.

b) A safety valve or rupture disc is to be arranged between the compressor and the delivery stop valve.

c) When the power exceeds 10 kW, the protection may consist of a pressure control device which automatically stops the machine in the event of overpressure. Details of the design of this device are to be submitted to the Society.

d) Compressors arranged in parallel are to be provided with check valves in the discharge line of each compressor.

e) Means are to be provided to indicate the correct direction of rotation.

7.3 Reciprocating compressors

7.3.1 Crankcase

a) When subjected to refrigerant pressure, compressor crankcases are to be either:
   - designed to withstand the rated working pressure of the LP side; or
   - fitted with safety valves designed to lift at a pressure not exceeding 0,8 times the crankcase test pressure; in this case, arrangements are to be made for the refrigerant to discharge to a safe place; or
   - protected against overpressures by means of devices likely to ensure a similar protection.

b) An oil level sight glass is to be fitted in the crankcase.

c) Means are to be provided to heat the crankcase when the compressor is stopped if the power of the compressor technically required such an arrangement.

7.4 Pressure vessels

7.4.1 General

The general requirements of Pt C, Ch 1, Sec 14, [2.1.2] are applicable.

7.4.2 Refrigerant receivers

a) The receivers are to have sufficient capacity to accumulate liquid refrigerant during changes in working conditions, maintenance and repairing.

b) Each receiver is to be fitted with suitable level indicators. Glass gauges, if any, are to be of the flat plate type and are to be heat resistant. All level indicators are to be provided with shut-off devices.

c) Each receiver that may be isolated from the system is to be provided with an adequate overpressure safety device.

7.4.3 Evaporators and condensers

a) All parts of evaporators and condensers are to be accessible for routine maintenance; where deemed necessary, efficient means of corrosion control are to be provided.

b) Safety valves are to be fitted on the shells of evaporators and condensers when the pressure from any connected pump may exceed their anticipated working pressure.

7.4.4 Air coolers

a) Air coolers are to be made of corrosion-resistant material or protected against corrosion by galvanising.

b) Air coolers are to be provided with drip trays and adequate drains.

7.5 General requirements for piping

7.5.1 General

The general requirements of Pt C, Ch 1, Sec 14, [2.1.3] are applicable.

7.5.2 Piping arrangement

a) Pipelines are to be adequately supported and secured so as to prevent vibrations. Approved type flexible hoses may be used where necessary to prevent vibrations.

b) Provision is to be made for allowing thermal expansion and contraction of the piping system under all operating conditions. Approved type flexible hoses may be used where necessary for this purpose.

c) Where necessary, pipe insulation is to be protected from mechanical damage and is to be provided with an efficient vapour barrier which is not to be interrupted in way of supports, valves, fittings, etc.

7.6 Accessories

7.6.1 Oil separators

Oil separators with drains are to be fitted on the refrigerant lines. When a wire gauze is fitted, this is to be of material which cannot be corroded by the refrigerant.

7.6.2 Filters

a) Efficient filters are to be fitted at the suction of compressors and on the high pressure side of reducing valves. The filters of compressors may be incorporated in the crankcases, provided their filtering area is sufficient.

b) Filters are to be fitted with a wire gauze strainer which cannot be corroded by the refrigerant and allowing a sufficient flow area for the fluid. Small filters such as those of reducing valves are to be such that they can be easily removed without any disassembling of the pipes.

7.6.3 Dehydrators

An efficient dehydrator is to be fitted. The dehydrator is to be so designed and arranged that the drying product can be replaced without any disassembling of the pipes.

7.7 Refrigerating plant overpressure protection

7.7.1 General

a) The refrigerant circuits and associated pressure vessels are to be protected against overpressure by safety valves, rupture discs or equivalent arrangement. However, inadvertent discharge of refrigerant is to be prevented.

b) The safety devices are to be in such number and so located that there is no possibility that any part of the system may be isolated from a safety device. Where it is necessary to be able to isolate one of these devices from the system for maintenance purposes, the valves may be duplicated provided a change-over valve is arranged in such a way that when one device is isolated it is not possible to shut off the other.

c) Pressure vessels connected by pieces of pipe without valves may be considered as a single pressure vessel from the point of view of overpressure protection, provided that the interconnecting pipe does not prevent effective venting of the vessels.

7.7.2 Safety valves

a) Safety valve discharges are to be led to a safe place above the deck. Discharge pipes are to be designed in such a way that the ingress of water, snow, dirt or debris affecting the operation of the system can be prevented.

b) Refrigerant pumps are to be fitted with safety valves at the discharge side. The valves may discharge at the pump suction side or at another suitable location.

c) After setting, safety valves are to be suitably protected against the possibility of inadvertent change of setting.

d) Safety valves are to lift at a pressure not more than 0,80 times the test pressure of the parts concerned.

8 Specific requirements for direct refrigerating systems

8.1 Specific requirements for air cooling systems and distribution and renewal of air in refrigerated spaces

8.1.1 Rated circulation

The air circulation system is to be so designed as to ensure as uniform as possible a distribution of air in refrigerated spaces.

8.1.2 Refrigerated air circulation systems

a) For air coolers, see [7.4.4].

b) Air coolers are to be designed for a maximum temperature difference between cooling medium and cooling air at the air cooler inlet of about 5°C for fruit cargoes and about 10°C for deep frozen goods.

c) The coils are to be divided into two sections, each capable of being easily shut off.

d) Means for defrosting the coils of the air coolers are to be provided. Defrosting by means of spraying with water is to be avoided.

e) Fans and their motors are to be arranged so as to allow easy access for inspection and repair and/or removal of the fans and motors themselves when the chambers are loaded with refrigerated goods. Where duplicate fans and motors are fitted and each fan is capable of supplying the quantity of air required, it is sufficient that easy access for inspection is provided.

f) The air circulation is to be such that delivery and suction of air from all parts of the refrigerated chambers are ensured.

g) The air capacity and the power of the fans are to be in proportion to the total heat to be extracted from the refrigerated chambers, due regard being given to the nature of the service.

9 Instrumentation, alarm, monitoring

9.1 General

9.1.1 Automation safety equipment

The automation safety equipment is to be of the fail-safe type and is to be so designed and installed as to permit manual operation. In particular, manual operation of the compressors is to be ensured in the event that any of the equipment is inoperable.

9.1.2 Regulation devices

Regulation devices such as motor-operated valves or thermostatic expansion valves are to be such that they can be isolated, thus allowing the plant to be manually operated should the need arise.

9.2 Instrumentation, alarm and monitoring arrangement

9.2.1 Compressors

Tab 4 summarises the minimum control and monitoring requirements for refrigerating compressors.

9.2.2 Refrigerating systems

Tab 5 summarises the minimum control and monitoring requirements for refrigerating systems.

Table 4 : Refrigerating compressors

Item	Indicator	Function			Comments
			Alarm	Automatic shutdown	
Refrigerant suction	pressure	low		X	At saturated temperature and including intermediate stages
Refrigerant discharge	pressure	high		X	
Refrigerant suction	temperature				For installations over 25 kW only
Refrigerant discharge	temperature				
Lubricating oil	pressure	low		X	
Lubricating oil	temperature				For installations over 25 kW only
Cooling water	temperature				For installations over 25 kW only
Cumulative running hours	hours				All screw compressors and installations over 25 kW only
Note 1: Shutdown is also to activate an audible and visual alarm, locally or at remote position.					

Table 5 : Refrigerating systems

Item	Indicator	Function			Comments
			Alarm	Automatic shutdown	
Chamber temperature	temperature		X		
Bilge level in refrigerated space		high	X		
Note 1: Audible and visual alarm to be activated locally or at remote position.					

10 Material tests, inspection and testing, certification

10.1 Material testing

10.1.1 The materials for the construction of the parts listed below are to be tested in compliance with the requirements of NR216 Materials and Welding:

- compressor crankshafts, couplings, connecting rods and piston rods
- compressor liners, cylinder heads and other parts subjected to pressure
- steel and copper tubing for evaporator and condenser coils and for pressure piping in general
- oil separators, intermediate receivers and other pressure vessels included in the gas circuit
- condensers and evaporators of shell type (tube or welded plate).

10.2 Shop tests

10.2.1 Individual pieces of equipment

Shop tests are to be carried out on pumps, electric motors and internal combustion engines forming parts of refrigerating installations, following procedures in accordance with the requirements applicable to each type of machinery. The relevant running data (capacity, pressure head, power and rotational speed, etc.) are to be recorded for each item.

10.2.2 Refrigerating unit

a) At least one refrigerating unit of each type installed on board is to be subjected to shop tests in order to ascertain its refrigerating capacity in the most unfavourable temperature conditions expected, or in other temperature conditions established by the Society.

b) Where the complete unit cannot be shop tested (for instance, in the case of direct expansion installations), only the compressors are to be tested according to procedures approved by the Society.

10.3 Pressure tests at the workshop

10.3.1 Strength and leak tests

Upon completion, all parts included in the suction and delivery branches of the refrigerant circuit are to be subjected to a strength and leak test.

The strength test is a hydraulic test carried out with water or other suitable liquid. The leak test is a test carried out with air or other suitable gas while the component is submerged in water at a temperature of approximately 30°C.

The components to be tested and the test pressure are indicated in Tab 6.

10.3.2 Condensers

Circulating water sides of condensers are to be subjected to a hydrostatic test at a pressure equal to 1,5 times the design pressure, but in no case less than 0,1 N/mm^2.

10.4 Thermometers and manometers

10.4.1 The following requirements shall be fulfilled:

a) All thermometers recording the temperature of refrigerated spaces, the air temperature at the inlet and outlet of air coolers and the temperature at various points in the refrigerant circuit or in the brine circuit are to be carefully calibrated by the Manufacturer. The Society reserves the right to require random checks of the calibration.

b) The accuracy of manometers and other measuring instruments is also to be checked before the commencement of the tests required in [10.5].

Table 6 :

Component	Test pressure	
	Strength test	Leak test
Compressor cylinder blocks, cylinder covers, stop valves, pipes and other components (condensers, receivers, etc.) of the high pressure part of the circuit.	1,5 p_1	p_1
Compressor crankcases subjected to refrigerant pressure, stop valves, pipes and other components of the low pressure part of the circuit.	1,5 p_2	p_2
Where p_1 and p_2 are the design pressures indicated in [6.2] for high pressure and low pressure parts.		

10.5 Shipboard tests

10.5.1 Pressure tests

After installation on board, and before operating, the plant is to be subjected to a test at the maximum working pressure determined as indicated in [6.2.1].

However, all pressure piping portions which have welded joints made on board are to be subjected to a strength test at a pressure equal to 1,5 times the rated working pressure before being insulated.

After the pressure test, and before charging with refrigerant, a vacuuming and a drying out of the complete refrigerating plant is to be carried out.

Air tightness of the refrigerated chambers is to be checked.

10.5.2 Tests of the ventilation system

After installation, the ventilation system is to be tested. The distribution of air in the various refrigerated spaces is to be checked.

10.5.3 Operational tests

a) Upon completion of the installation, each refrigerating plant is to be subjected to an operational test on board in order to check the proper operation of the machinery and the refrigerating capacity of the unit.

b) Before starting the actual test, the Surveyor will check at random that thermometers, pressure gauges and other instruments are in working order, calibrated and arranged as directed in each case by the Society.

c) All the refrigerating machinery is to be put into service and all chambers, closed and empty, are to be simultaneously cooled to the minimum expected temperature, i.e. the temperature required to be entered in the notation, or a lower temperature determined so that a difference of at least 20 °C can be maintained between the average external temperature and the temperature in the refrigerated spaces. The expected temperature is to be maintained for a period of time sufficient to remove all the heat from the insulation.

d) The regulation of the refrigerating capacity of the plant may be effected by reducing the number of running compressors, by varying their rotational speed or even by running them intermittently.

e) The following data are to be recorded in the course of the test:
   - Temperatures in the refrigerated spaces, external air temperature and sea water temperature (in particular, at the outlet and inlet of the condensers).
   - Absorbed power and speed of the compressors and the temperatures and pressures which determine the running of the refrigerating machinery.
   - Absorbed power of the motors driving the fans F_V and brine pumps F_P
   - Temperatures and pressures at various locations along the refrigerant circuits
   - Air temperatures at the inlet and outlet of air cooler.

f) Particular cases, e.g. when the test is carried out with very low external atmospheric temperatures which would require the temperature within the refrigerated spaces to be brought down below the above specified values, or where tests with empty chambers are not deemed sufficient/significant, will be specially considered by the Society. In particular, the following may be required:
   - appropriate testing conditions, such as simulation with equivalent thermal loading or chamber heating, and/or
   - a copy of the log book of the refrigerated chambers, including the temperature reading, after the first loaded voyage.

10.6 Defrosting system

10.6.1 The defrosting arrangements are also to be subjected to an operational test.

Instructions regarding the procedure to be followed for the operational test of the refrigerating plant on board will be given by the Society in each case.

Section 4 Centralised Navigation Equipment (SYS-NEQ)

1 General

1.1 Application

1.1.1 The additional class notation **SYS-NEQ** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.6.1], to ships fitted with a centralised navigation control system so laid out and arranged that it enables normal navigation and manoeuvring operation of the ship by two persons in cooperation.

This notation is assigned when the requirements of Articles [1] to [5], [7] and [8] of this Section are complied with.

1.1.2 The additional class notation **SYSNEQ-1** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.6.1], when, in addition to [1.1.1], the installation is so arranged that the navigation and manoeuvring of the ship can be operated under normal conditions by one person for periodical one man watches. This notation includes specific requirements for prevention of accidents caused by the operator's unfitness.

This notation is assigned when the requirements of this Section are complied with.

1.1.3 The composition and the qualification of the personnel on watch remain the responsibility of the Owner and the Administration. The authorisation to operate the ship in such condition remains the responsibility of the Administration.

1.2 Operational assumptions

1.2.1 The requirements are framed on the following assumptions:

- Plans for emergencies are specified and the conditions under which a one man watch is permitted are clearly defined in an operations manual which is acceptable to the Administration with which the ship is registered.
- The manning of the bridge watch is in accordance with the national regulations in the country of registration and for the waters in which the ship is operating.
- The requirements of the International Convention on Standards of Training Certification and Watchkeeping for seafarers (STCW) and other applicable statutory regulations are complied with.

1.3 Regulations, guidelines, standards

1.3.1 The requirements are based on the understanding that the applicable regulations and guidelines issued by the International Maritime Organisation are complied with, in particular:

a) Regulations 15 to 28, Chapter V of the 1974 "International Convention for the Safety of Life at Sea" (SOLAS) and applicable amendments

b) The international Regulations for Preventing Collisions at Sea and all other relevant Regulations relating to Global Maritime Distress and Safety System (GMDSS) and Safety of Navigation required by Chapters IV and V of SOLAS 1974, as amended

c) the Provisional Guidelines for the Conduct of Trials in which the Officer of the Navigational Watch acts as the sole Lookout in Periods of Darkness (MSC Circular 566 of 2 July 1991)

d) IMO A.694: 1991, General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids

e) MSC Circular 982, Guidelines on ergonomic criteria for bridge equipment and layout

f) Convention on the International Regulations for Preventing Collision at Sea, 1972 (COLREG)

g) IMO Performance Standards for navigational equipment applicable to:
   - magnetic compasses (Resolution A.382)
   - gyrocompasses (Resolution A.424)
   - performance standards for radar equipment (Resolution MSC.192(79))
   - speed and distance measuring equipment (Resolution A.478, A.824, MSC.96 (72))
   - echo sounding equipment (Resolution A.224, MSC.74 (69) Annex 4)
   - electronic navigational aids – general requirements (Resolution A.574)
   - VHF Radio installation (Resolution MSC.68 (68) Annex 1, A.524 (13), A.803 (19))
   - heading control systems (HCS) (Resolution A.342, MSC.64 (67) Annex 3)
   - rate-of-turn indicators (Resolution A.526)
   - VHF watchkeeping receiver (Resolution A.803 (19), MSC.68 (68) Annex 1)

- Performance standards for track control systems (Resolution MSC.74 (69) Annex 2)
- Performance standards for marine transmitting heading devices (THDs) (Resolution MSC.116 (73))
- Performance standards for electronic chart display and information systems (Resolution A.817 (19), MSC.86 (70) Annex 4, MSC.64 (67) Annex 5)
- Maintenance of electronic chart display and information system (ECDIS) software (IMO circ.266)
- Performance standards for shipborne global positioning system receiver equipment (Resolution A.819 (19))
- Adoption of the revised performance standards for shipborne global positioning system (GPS) receiver equipment (Resolution MSC.112 (73))
- Adoption of the revised performance standards for shipborne GLONASS receiver equipment (Resolution MSC.113 (73))
- Adoption of the revised performance standards for shipborne DGPS and DGLONASS maritime radio beacon receiver equipment (Resolution MSC.114 (73)).
- Performance standards for a universal automatic identification system (AIS) (Resolution MSC.74 (69) Annex 3)
- Performance standards for an integrated navigation system (INS) (Resolution MSC.86 (70) Annex 3)
- Performance standards for sound reception systems (Resolution MSC.86 (70) Annex 1)
- performance standards for the presentation of navigation-related information on shipborne navigational displays (Resolution MSC.191(79))
- performance standards for a bridge navigational watch alarm system (BNWAS) (Resolution MSC.128(75))
- performance standards for shipborne voyage data recorders (VDRs) (Resolution A.861(20) as amended by IMO Res. MSC.214(81))

1.3.2 The requirements and guidelines of ISO 8468 – ed. 3 “Ship’s bridge layout and associated equipment– Requirements and guidelines” are applicable.

1.3.3 Additional requirements may be imposed by the national authority with whom the ship is registered and/or by the Administration within whose territorial jurisdiction it is intended to operate.

1.4 Definitions

1.4.1 Terms used in the requirements are defined below:

- Acquisition: the selection of those target ships requiring a tracking procedure and the initiation of their tracking
- Alarm: a visual and audible signal indicating an abnormal situation
- ARPA: automatic radar plotting aid
- Backup navigator: any individual, generally an officer, who has been designated by the ship’s Master to be on call if assistance is needed on the navigation bridge
- Bridge: that area from which the navigation and control of the ship is exercised, including the wheelhouse and bridge wings
- Bridge wings: those parts of the bridge on both sides of the ship's wheelhouse which, in general, extend to the ship side
- CPA: closest point of approach, i.e. the shortest target ship-own ship calculated distance that will occur in the case of no change in course and speed data
- Conning position: the place in the wheelhouse with a commanding view and which is used by navigators when monitoring and directing the ship mouvements
- Display: means by which a device presents visual information to the navigator, including conventional instrumentation
- Ergonomics: application of the human factor in the analysis and design of equipment, work and working environment
- Field of vision: angular size of a scene that can be observed from a position on the ship's bridge
- Lookout: activity carried out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision
- Navigation: all tasks relevant for deciding, executing and maintaining course and speed in relation to waters and traffic
- Navigator: person navigating, operating bridge equipment and manoeuvring the ship
- NAVTEX: an international maritime radio telex system sponsored by IMO and IHO, which automatically receives the broadcast telex information such as navigational, meteorological warnings and search and rescue (SAR) alerts on a 24-hour watch basis
- Normal conditions: when all systems and equipment related to navigation operate within design limits, and environmental conditions such as weather and traffic do not cause excessive workload to the officer of the watch
- Officer of the watch: erson responsible for safe navigating, operating of bridge equipment and manoeuvring of the ship
- OMBO: one man bridge operation
- OMBO ship: one man bridge operated ship

- Radar plotting: the whole process of target detection, tracking, calculation of parameters and display of information
- Seagoing ship: ship navigating on the high seas, i.e. areas along coasts and from coast to coast
- TCPA: time to closest point of approach
- Tracking: process of observing the sequential changes in the position of a target, to establish its motion
- Vigilance system: system provided to verify the officer of the watch’s alertness
- Watch alarm: alarm that is transferred from the bridge to the Master and the backup navigator in the event of any officer of the watch deficiency (absence, lack of alertness, no response to another alarm/warning, etc.)
- Wheelhouse: enclosed area of the bridge
- Workstation: position at which one or several tasks constituting a particular activity are carried out.

2 Documentation

2.1 Documents to be submitted

2.1.1 In addition to the documents mentioned in Pt C, Ch 3, Sec 1, Tab 1, and the requirement in Pt C, Ch 3, Sec 1, [2.2.1], documents according to Tab 1 are to be submitted.

2.1.2 Additional plans and specifications are to be submitted for approval, if requested by the Society.

3 Bridge layout

3.1 General

3.1.1 The bridge configuration, the arrangement of consoles and equipment location are to enable the officer of the watch to perform navigational duties and other functions allocated to the bridge as well as maintain a proper lookout from a convenient position on the bridge, hereafter referred to as a 'workstation'.

3.1.2 A workstation for navigation and traffic surveillance/manoeuvring is to be arranged to enable efficient operation by one person under normal operating conditions. All relevant instrumentation and controls are to be easily visible, audible and accessible from the workstation.

3.1.3 The bridge layout design and workstations are to enable the ship to be navigated and manoeuvred safely by two navigators in cooperation.

3.1.4 The requirements and guidelines of the ISO 8468 Standard are to be regarded as a basic reference for the design of bridge layout.

4 Bridge instrumentation and controls

4.1 General

4.1.1 The instrumentation and controls at the workstation for navigation and traffic surveillance/manoeuvring are to be arranged to enable the officer of the watch to:

a) determine and plot the ship's position, course, track and speed
b) analyse the traffic situation
c) decide on collision avoidance manoeuvres
d) alter course
e) change speed
f) effect internal and external communications related to navigation and manoeuvring, radio communication on the VHF
g) give sound signals
h) hear sound signals
i) monitor course, speed, track, propeller revolutions (pitch), rudder angle and depth of water
j) record navigational data (may be manually recorded from data available at the workstation).

4.1.2 Irrespective of their size, gross tonnage and date of construction, all ships assigned the additional class notation **SYS-NEQ** are to be equipped with the instrumentation and controls described in [4.2] to [4.4] and as referred to in Tab 2.

Table 1 : Documentation to be submitted

No.	I/A **(1)**	Documentation
1	A	General arrangement of bridge and wheelhouse showing the position of the control console and panels
2	A	Plans showing the field of vision from each workstation
3	A	List and specification of navigational equipment fitted on the bridge and references (Manufacturer, type, national authority approval...)
4	A	Functional block diagram indicating the relationship between the items of navigational equipment and between them and other equipment
5	A	List of alarms and instrumentation fitted on the bridge
6	A	Diagram of electrical supply to the navigational equipment
7	A	Diagram of the system linking the bridge alarms with the other operational locations **(2)**
8	A	Diagram of the navigation officer's call system **(2)**
9	A	Diagram of the communication systems **(2)**
10	A	Diagram of the vigilance systems **(2)**
11	A	Test program including test method
12	I	List of the intended area of operation of the ship

(1) A : to be submitted for approval
I : to be submitted for information.
(2) Documents to be submitted only when a **SYSNEQ-1** notation is requested.

Table 2 : List of mandatory equipment

Equipment	Additional class notations	
	SYS-NEQ	**SYS-NEQ 1**
Multifunction displays - according to MSC.191(79)	optional	optional
Radar **(1)**	CAT 1(H)/2(H)/3(H)	CAT 1(H)"
Gyrocompass	one	one
Magnetic compass	yes	yes
Spare magnetic compass or second gyrocompass fed by main and emergency power supply and in addition by a transitional power supply (e.g. battery)	yes	yes
Transmitting Heading Device (THD)	yes	yes
Heading Control System (HCS), formerly autopilot	yes	yes
ECDIS with backup	yes	yes
Position receiver (GNSS …)	one	one
Bridge Navigation Watch Alarm System (BNWAS)	yes	yes
Call system (back-up Officer)	yes	yes
Alarm transfer system	yes, at least to master's cabin	yes, at least to master's cabin
Central alarm panel	yes	yes
Echo sounder	yes	yes
Speed Distance and Measuring Equipment (SDME)**(2)**	yes	yes
Sound reception (if totally enclosed bridge)	yes	yes
VHF at conning position	one	one
A receiver capable of receiving MSI and search and rescue related information (e.g. NAVTEX)	yes	yes
Weather chart facsimile	yes	yes
Wind speed and direction	yes	yes
AIS	yes	yes
VDR	yes	yes

(1) According to [4.2.1]
H: when approved for high speed application
(2) Speed of the ship through the water and over the ground

Table 3 : Categories of ship with their radar performance requirements

	Category of ship		
	CAT 3	CAT 2	CAT 1
Size of ship/craft	<500 gt	500 gt to < 10000 gt	≥ 10000 gt
Minimum operational display area diameter	180 mm	250 mm	320 mm
Minimum display area	195 mm x 195 mm	270 mm x 270 mm	340 mm x 340 mm
Auto acquisition of targets	-	-	yes
Minimum acquired radar target capacity	20	30	40
Minimum activated AIS target capacity	20	30	40
Minimum sleeping AIS target capacity	100	150	200
Trial manoeuvre	-	-	yes

4.2 Safety of navigation: collision-grounding

4.2.1 The ship is to be equipped with an RADAR/ARPA system meeting the requirements of IMO Resolution MSC.192(79)).

The categories of ship with their radar performance requirements are specified in Tab 3.

4.2.2 An heading control system (HCS) is to be provided and monitored by a heading alarm addressed to the navigator, in case of malfunction. This alarm is to be derived from a system independent from the automatic steering system. An overriding control device is to be provided at the navigating and manoeuvring workstation.

4.3 Position fixing

4.3.1 Ships are to be provided with the following position systems:

a) position fixing systems appropriate to the intended service areas

b) at least two independent radar, one of which is to operate within the X-band

c) a gyrocompass system

d) a speed log system

e) an echo sounding system.

f) an ECDIS with backup arrangement.

4.4 Controls - Communication

4.4.1 Ships are to be provided with the following control and communication:

a) a propulsion plant remote control system, located on the bridge

b) a whistle control device

c) a window wipe and wash control device

d) a main workstation console lighting control device

e) steering pump selector/control switches

f) an internal communication system

g) a VHF radiotelephone installation

h) a wheelhouse heating/cooling control device

i) a receiver capable of receiving MSI and search and rescue related information (e.g. NAVTEX) automatic receiver and recorder.

Note 1: The systems or controls under a) to g) are to be fitted within the reach of the officer of the watch when seated or standing at the main navigating and manoeuvring workstation.

5 Design and reliability

5.1 General

5.1.1 Where computerised equipment is interconnected through a computer network, failure of the network is not to prevent individual equipment from performing its individual functions.

5.2 Power supply

5.2.1 Power supply for AC equipment

a) Power to navigation equipment is to be supplied by two circuits, one fed directly from the main source of electrical power, and one fed directly from the emergency source of power. Power to radio equipment is also to be supplied by two circuits as described above and is additionally to be supplied by a reserve source of energy.

b) The power supplies to the distribution panels are to be arranged with automatic change-over facilities between the two sources.

c) The distribution of supplies to navigation equipment is to be independent of those for radio equipment. The circuits from the power sources is to be terminated either in one or two distribution panels. When one distribution panel is used, the two circuits supplying power to the panel are to be provided with split feeds into two separate bus bars, one for the radio equipment and one for the navigation equipment. The panel(s) is(are) to be sited on the navigation bridge or other suitable position on the bridge deck.

d) The circuits supplying the board(s) are, as far as practicable, to be separated from each other throughout their length. Facilities are to be provided in each distribution board for changing over between the main source of power and the emergency source of power. It is preferable that change over be initiated automatically. When a single distribution board is used for both radio and navigation equipment, separate change-over switches are to be provided for each service.

e) Where radio equipment requires an uninterrupted input of information from the ship's navigational equipment or other equipment, it is necessary for the equipment providing the data to be supplied from the same distribution board bus serving the radio equipment rather than the bus bar serving the navigation equipment.

f) Failure of any power supply to the panel is to initiate and audible and visual alarm at the navigation bridge.

g) Each consumer is to be individually connected to the distribution panel bus bar and individually provided with short-circuit protection.

h) An indicator is to be mounted in a suitable place to indicate when batteries of the reserve source of energy are being discharged.

5.2.2 Power supply for DC equipment

a) The requirements of [5.2.1] are applicable.

b) Where the equipment is fed via converters, separate converters are to be provided and these are to be located on the supply side of change-over facility.

c) The radio equipment and the navigation equipment are to be provided with separate converters.

5.2.3 Power supply for equipment operated either AC or DC

a) Each consumer is to be individually connected to the main source of electrical power and to a distribution bus bar of the panel which is fed from the emergency source of electrical power and also, in case of the radio equipment, from the reserve source of energy (radio batteries). These two circuits are to be separated throughout their length as fas as practicable.

b) The radio equipment and the navigation equipment are to be provided with separate converters.

c) An indicator is to be mounted in a suitable place visible for responsible member of the crew to indicate when batteries of the reserve source of energy are being discharged.

5.2.4 Following a loss of power which has lasted for 30 seconds or less, all primary functions are to be readily reinstated. Following a loss of power which has lasted for more than 30 seconds, as many primary functions as practical are to be readily reinstated.

5.3 Environmental conditions

5.3.1 Shipborne navigational equipment specified in IMO Publication 978-88-04E "PERFORMANCE STANDARDS FOR NAVIGATIONAL EQUIPMENT" is to be capable of continuous operation under the conditions of various sea states, vibration, humidity, temperature and electromagnetic interference likely to be experienced in the ship in which it is installed.

5.3.2 Equipment which has been additionally specified in this notation is to comply with the environmental conditions specified in Pt C, Ch 2, Sec 2 for control and instrumentation equipment, computers and peripherals for shipboard use.

6 Prevention of accidents caused by operator's unfitness

6.1 Bridge safety system

6.1.1 A vigilance system is to be provided to indicate that an alert officer of the navigational watch is present on the bridge.

6.1.2 Any system used for verification of the officer of the navigational watch's alertness is not to cause undue interference with the performance of bridge functions.

6.1.3 The system is to be so designed and arranged that it cannot be operated in an unauthorised manner, as far as practicable.

6.1.4 Any system used for periodical verification of the officer of the navigational watch's alertness is to be adjustable up to 12 minutes intervals and constructed, fitted and arranged so that only the ship's Master has access to the component for setting the appropriate intervals.

6.1.5 The system is to provide for the acknowledgement by the officer of the navigational watch at the navigating and traffic surveillance/manoeuvring workstation and other appropriate locations in the bridge from where a proper lookout may be kept.

6.1.6 Such system is to be connected to the alarm transfer system described in [6.3].

6.1.7 An alarm is to operate on the bridge in the event of a failure of the bridge safety systems.

6.1.8 The requirements of [6.1.1] to [6.1.7] do not prevent the Society from accepting any technical systems that adequately verify or help maintain the alertness of the officer of the watch at intervals up to 12 minutes.

6.2 Field of vision

6.2.1 For the purpose of performing duties related to navigation, traffic surveillance and manoeuvring, the field of vision from a workstation is to be such as to enable observation of all objects which may affect the safe conning of the ship. The field of vision from a workstation is to be in accordance with the guidelines on navigation bridge visibility, as specified in IMO Resolution A.708, MSC Circular 982 and ISO 8468 ed.3 as it applies to new ships.

6.3 Alarm/warning transfer system - Communications

6.3.1 Any alarm/warning that requires bridge operator response is to be automatically transferred to the Master and, if he deems it necessary, to the selected backup navigator and to the public rooms, if not acknowledged on the bridge within 30 seconds.

Such transfer is to be carried out through the systems required by [6.3.3] and [6.3.7], where applicable.

6.3.2 Acknowledgement of alarms/warnings is only to be possible from the bridge.

6.3.3 The alarm/warning transfer is to be operated through a fixed installation.

6.3.4 Provision is to be made on the bridge for the operation of a navigation officer call-alarm to be clearly audible in the spaces of [6.3.1].

6.3.5 The alarm transfer system is to be continuously powered and have an automatic change-over to a standby power supply in the case of loss of normal power supply.

6.3.6 At all times, including during blackout, the officer of the watch is to have access to facilities enabling two-way speech communication with another qualified officer.

The bridge is to have priority over the communication system.

Note 1: The automatic telephone network is acceptable for this purpose, provided that it is automatically supplied during blackouts and that it is available in the locations specified in [6.3.1].

6.3.7 If, depending on the shipboard work organisation, the backup navigator may attend locations not connected to the fixed installation(s) described in [6.3.1], he is to be provided with a portable wireless device enabling both the alarm/warning transfer and the two-way speech communication with the officer of the watch.

6.3.8 External sound signals from ships and fog signals that are audible on open deck are also to be audible inside the wheelhouse; a transmitting device is to be provided to reproduce such signals inside the wheelhouse (recommended frequency range: 70 to 700 Hertz).

6.4 Bridge layout

6.4.1 The bridge configuration, the arrangement of consoles and equipment location are to enable the officer of the watch to maintain a proper lookout from a convenient workstation.

6.4.2 A workstation for navigation and traffic surveillance/manoeuvring is to be arranged to enable efficient operation by one person under normal operating conditions.

7 Ergonomical recommendations

7.1 Lighting

7.1.1 The lighting required on the bridge should be designed so as not to impair the night vision of the officer on watch. Lighting used in areas and at items of equipment requiring illumination whilst the ship is navigating is to be such that night vision adaptation is not impaired, e.g. red lighting. Such lighting is to be arranged so that it cannot be mistaken for a navigation light by another ship. It is to be noted that red lighting is not to be fitted over chart tables so that possible confusion in colour discrimination is avoided.

7.2 Noise level

7.2.1 The noise level on the bridge should not interfere with verbal communication and mask audible alarms.

7.3 Vibration level

7.3.1 The vibration level on the bridge should not be uncomfortable to the bridge personnel.

7.4 Wheelhouse space heating/cooling

7.4.1 Unless otherwise justified, wheelhouse spaces are to be provided with heating and air cooling systems. System controls are to be readily available for the officer of the watch.

7.5 Navigator's safety

7.5.1 There are to be no sharp edges or protuberances on the surfaces of the instruments and equipment installed on the bridge which could cause injury to the navigator.

7.5.2 Sufficient handrails or the equivalent are to be fitted inside the wheelhouse or around instruments and equipment therein for safety in bad weather.

7.5.3 Adequate means are to be made for anti-slip of the floor, whether it is dry or wet.

7.5.4 Doors to the bridge wings are to be easy to open and close. Means are to be provided to hold the doors open at any position.

7.5.5 Where provision for seating is made in the wheelhouse, means for securing are to be provided, having regard to storm conditions.

8 Testing

8.1 Tests

8.1.1 Documentary evidence in the form of certification and/or test results is to be submitted to the satisfaction of the Society. Where acceptable evidence is not available, the requirements of Pt C, Ch 3, Sec 6 are applicable.

8.1.2 Shipboard tests and sea trials are to be carried out in accordance with the test procedures submitted for approval in advance to the Society. Tests and trials are to be performed under the supervision of a Surveyor of the Society.

8.1.3 After fitting on board, the installations are to be submitted to tests deemed necessary to demonstrate correct operation. Some tests may be carried out at quay side, while others are to be effected at sea trials.

Section 5 Compartment Air Testing (AIRTEST)

1 General

1.1 Additional class notation AIRTEST

1.1.1 The additional class notation **AIRTEST** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.15.5] to ships where watertight boundaries have been subjected to leak test using a positive air pressure differential and a maximum allowable pressure loss as a criteria, in compliance with the requirements of this Section. The structural boundaries that comply with the requirements of this Section are to be listed in a memorandum.

1.2 Purpose

1.2.1 The aim of this additional class notation is to contribute to the identification of leaks in watertight boundaries so that they may be rectified, in order to reduce the risk of progressive flooding from a damaged to an intact compartment.

1.3 Application

1.3.1 The tests defined in this Section, herein referred to as compartment air tests, apply to all ships of the series.

1.3.2 Each boundary subject to verification is to be tested with a positive air pressure differential resulting from the pressurisation of a bounded compartment or space. Only one of the two adjoining compartments is to be pressurised at a time.

1.3.3 The tests are to be conducted from either one or both sides of each boundary, as necessary to verify the tightness of the structure and its fittings according to their characteristics and the direction(s) of water pressure that may be experienced in case of flooding. As a rule, tests will be required from each side where flooding is possible and testing is practicable.

1.3.4 Testing is to be carried out in the presence of a Surveyor of the Society.

1.4 Scope

1.4.1 The list of boundaries to be subjected to compartment air test is to be agreed with the Society.

1.5 Documentation to be submitted

1.5.1 The documentation listed in Tab 1 is to be submitted, in addition to relevant documentation requested in Part B.

Table 1 : Documentation to be submitted

N°	I/A **(1)**	Document
1	A	Test plan (see [3.1])
2	A	Test procedures (see [3.2])
3	A	Test reports (see [3.3])
4	I	Test register (see Article [6])
(1) A: to be submitted for approval, I: to be submitted for information.		

2 Design requirements

2.1 Structure

2.1.1 The design still water pressure, p_{ST}, is to be taken equal to the test pressure defined in Tab 2 for all boundaries subject to compartment air test.

2.1.2 The structural elements of boundaries subject to compartment air test are to comply with the requirements of Part B, Chapter 7 as applicable to testing conditions, for the design pressure given in [2.1.1].

Table 2 : Test pressures and maximum allowable pressure loss criteria

Boundary	Test pressure (kPa) **(1)**	Maximum allowable pressure loss (kPa)
Boundaries of machinery spaces below the bulkhead deck containing main propulsion or auxiliary engines	10	2,5
Boundaries of other compartments below the bulkhead deck		1
(1) The test pressure is given as a positive pressure differential, measured across the tested boundaries.		

2.2 Test fittings

2.2.1 Suitable fittings are to be provided for each space subject to compartment air test, in order to permit the connection of test equipment used for pressurisation and pressure measurement.

2.2.2 Any permanently installed test fittings are to be able to be made tight to a degree consistent with the tightness requirements for their location. In particular, see Pt B, Ch 2, Sec 1, [5].

2.3 Openings and crossings

2.3.1 Non-watertight openings situated above the V-lines in compliance with the requirements of Part B and Part C (e.g. openings for air ducts without permanently fitted watertight closures) are to be capable of being fitted with temporary closures such as blanking plates to ensure tightness sufficient for the conduct of compartment air testing.

2.3.2 Non-watertight crossings above the V-lines are to be, as far as possible, avoided in boundaries to be verified by compartment air test so that testing by this method will be practicable. If non-watertight crossings must be fitted, verification of affected boundaries by compartment air test will not be possible unless the crossings can be temporarily adjusted or configured to be watertight, in a manner deemed acceptable by the Society.

3 Test plan, test procedures and test reports

3.1 Test plan

3.1.1 The test plan is to outline the test program and is to include at least the following information:

- the boundaries to be verified, and a preliminary list of the openings, crossings and closing appliances in these boundaries
- list of compartments which will be pressurised to verify each boundary
- overview of apparatus and equipment setup for compartment pressurisation, depressurisation and pressure measurement
- overview of the pressurisation and depressurisation procedure
- overview of the leak detection procedure
- responsibilities of shipyard personnel.

3.2 Test procedures

3.2.1 Test procedures are to be submitted that address each compartment air test to be conducted, consistent with the test plan and clearly indicating the pass/fail criteria for each test step.

3.2.2 The test procedures are to include the definition of all necessary steps and checklists to ensure safe conduct of the test.

3.2.3 For compartment air tests, each procedure is to detail the steps to be taken and data to be recorded for at least the following aspects:

- identification of safety hazards and implementation of safety controls
- definition of the zone surrounding the compartment under test, access limitations, equipment deactivation and system lock-outs (including measures taken to prevent inadvertent depressurisation during test, especially for closures or other equipment that are remotely operable)
- definition of the test setup and installation of equipment and installation (schematics, flow rates, etc.)
- calibration of instruments
- list of the openings, crossings and closing appliances in the boundaries being tested
- prerequisites for testing
- configuration of the structural boundaries for testing (fitting of temporary closing elements, opening of closures in internal non-tight boundaries)
- ambient conditions
- test pressure and maximum allowable pressure loss for the compartment under test (refer to [4.2])

- application of test pressure at a defined rate of pressurisation, including the sequence of opening and closing of valves in the pressurisation circuit
- measurement of pressure and record of pressure loss
- restoration of normal atmospheric pressure at a defined rate of depressurisation
- removal of temporary fittings and closures and restoration of normal configuration of boundaries, equipment and systems
- Leak identification and rectification .

3.3 Test reports

3.3.1 Completed test procedures are to be submitted for each test, detailing the results and observations.

3.3.2 The actions taken to identify and rectify leaks are also to be included, as applicable.

4 Compartment air tests

4.1 Prerequisites

4.1.1 The relevant inspections and checks required in Pt B, Ch 11, Sec 1 are to be completed prior to the compartment air tests for elements constituting the boundaries under test.

4.1.2 A visual inspection of the compartment boundaries is to be conducted prior to testing to establish their initial condition.

4.1.3 Watertight closing appliances in the boundaries to be tested are to be configured closed.

4.1.4 Non-tight openings fitted in watertight boundaries and situated inside or above the V-lines in compliance with the requirements of Part B and Part C are to be fitted with temporary closures to permit compartment air testing.

Note 1: The possibility to fit such temporary closures is to be foreseen at the design stage as per [2.3].

4.1.5 Crossings for shafts fitted in watertight boundaries in compliance with the requirements of Part B and Part C may, if agreed with the Society, be temporarily adjusted to ensure tightness sufficient for the conduct of compartment air testing. Such adjustments will be considered by the Society on a case-by-case basis.

4.1.6 Testing is to be conducted at a stage sufficiently close to completion of work so that any subsequent work will not affect the tightness of the structure.

4.1.7 Locations where leaks may originate are to be sufficiently clean so as not to interfere with testing, to the satisfaction of the Surveyor.

4.1.8 Access closures within non-watertight boundaries inside compartments under test are to be open during testing.

4.1.9 Testing of structural boundaries formed by the shell plating below the waterline are to be conducted without the ship being afloat.

4.1.10 Where testing of liquid capacity boundaries is to be conducted, these verifications are to occur when the boundaries are not immersed.

4.1.11 Testing may be carried out at the block stage of construction, provided that all work on the block that may affect the tightness of the compartment boundaries has been completed.

4.1.12 Equipment or systems within the compartment under test and whose operation may be triggered by the change in air pressure are to be deactivated. Care is to be taken to avoid damage to items that may be affected by the application of the test pressure.

4.1.13 All actions taken to configure a compartment and its boundaries for testing are to be recorded in the test report.

4.1.14 Testing is to be conducted under ambient conditions, inside and outside of the compartment under test, that are sufficiently stable over the test duration so that they do not influence the pressure measurements.

4.2 Pass / fail criteria

4.2.1 For each watertight boundary it is to be verified that the measured pressure loss does not exceed the applicable maximum allowable value given in Tab 2, over a test duration of 10 minutes for the test pressure indicated.

Note 1: The test duration is to begin once the space under test has been isolated from the pressure source.

4.2.2 In addition to the criteria in [4.2.1], actions are to be taken to identify and rectify leaks to the satisfaction of the Surveyor (refer to [4.4]).

4.3 Test apparatus

4.3.1 The test pressure is to be applied via an apparatus and test setup that prevents over-pressurisation beyond the test pressure.

4.3.2 A U-tube with a height sufficient to hold a head of water corresponding to the required test pressure is to be arranged. The cross-sectional area of the U-tube is not to be less than that of the circuit supplying air.

In addition, the test pressure is also to be verified by means of one master pressure gauge.

4.3.3 Means other than a U-tube and deemed to be equally reliable may be used in agreement with the Society.

Note 1: Acceptability of alternative arrangements, including those involving the use of two calibrated pressure gauges to verify the required test pressure, will depend on an evaluation of the risks after taking into account necessary precautions and whether the design of the mechanism is similar to the U-tube principle (i.e. suitable to be lifted by the predetermined excessive pressure, and not subject to any kind of spring or restricting device). The following points are also to be considered:

- If an arrangement depending upon a safety valve is selected, in some cases, this approach has resulted in catastrophic failure of the space being tested
- Releasing mechanisms or safety valves are to be of adequate size/rating
- Test pressure gauges (a minimum of two are to be provided) are to be calibrated and of suitable range as per test pressure
- Inlet, outlet and release arrangement for the test medium to or from the item being tested are to be properly fabricated and supported, including their appropriate dimensions (e.g. smaller diameter for inlets and bigger diameter for outlets, as well as releasing means).

4.4 Leak identification and rectification

4.4.1 A description of the actions conducted during the tests to identify and rectify the origin of pressure loss is to be recorded.

4.4.2 Identified origins of leaks are to be recorded in the test report.

4.4.3 Rectification of leaks is to occur only after the space has been depressurised to atmospheric pressure.

4.4.4 The actions taken to rectify leaks are to be to the satisfaction of the Surveyor.

4.4.5 Testing is to be repeated following rectification of leaks in order to verify the pass/fail criteria in [4.2.1].

4.5 Post-test inspections and actions

4.5.1 After testing, the tested boundaries are to be examined for structural distortion, bulging and buckling and other related damage.

4.5.2 Temporary adjustments or configuration changes made to permit compartment air testing are to be undone after testing has been completed.

5 Modifications and repairs

5.1 General

5.1.1 The Society is to be informed of modifications or repair work carried out during construction which may affect the watertightness of any previously tested boundary prior to assignment of the notation.

5.1.2 Boundaries or parts thereof that have been subjected to modifications or repair work that may affect watertightness are to have their tightness verified by a leak test method according to the requirements of Pt B, Ch 11, Sec 3. In the case of boundaries that were previously verified by compartment air test as an alternative to hose test in accordance with Pt B, Ch 11, Sec 3, [3.3.1], ultrasonic detection techniques or an equivalent test may be used as a means of leak test for the modified or repaired elements in the boundary, according to a defined procedure that will be subject to approval by the Society. The verifications are to be carried out in the presence of the attending Surveyor and documented to the satisfaction of the Society.

5.1.3 For boundaries subject to modification or repair work affecting watertightness and which were previously verified by compartment air test as an alternative to hose test in accordance with Pt B, Ch 11, Sec 3, [3.3.1], the Society reserves the right to request that another compartment air test be conducted if deemed necessary due to the extent or nature of the modifications or repair work.

6 Compartment air test register

6.1 General

6.1.1 A document is to be provided to the Society and kept up to date with a summary of all leak tests conducted to verify tightness of each boundary covered by the additional class notation **AIRTEST**.

6.1.2 For each boundary, the following information concerning the conduct of compartment air tests is to be recorded in the register:

- the compartments that were pressurised to verify the boundary
- the test pressure and pressure loss criteria applicable in each case
- measured pressure loss and summary of test observations
- dates of tests.

6.1.3 For boundaries that have been subjected to modifications or repair work affecting watertightness, the following information is to be recorded in the register:

- the nature of the modifications or repair work
- description and results of the specific tightness verifications conducted
- dates of tests.

BUREAU VERITAS MARINE & OFFSHORE

Tour Alto
4 place des Saisons
92400 Courbevoie - France
+33 (0)1 55 24 70 00

marine-offshore.bureauveritas.com/rules-guidelines

BUREAU VERITAS

Shaping a World of Trust