Rules for the Classification of Naval Ships

Effective from 1 January 2017

Part E

Additional Class Notations

Emirates Classification Society (Tasneef)
Aldar HQ 19th Floor,
Al Raha Beach, Abu Dhabi, UAE
Abu Dhabi, United Arab Emirates

Phone (+971) 2 692 2333
Fax (+971) 2 445 433
P.O. Box. 111155
info@tasneef.ae

GENERAL CONDITIONS

Definitions:

"*Administration*" means the Government of the State whose flag the Ship is entitled to fly or under whose authority the Ship is authorised to operate in the specific case.

"IACS" means the International Association of Classification Societies.

"*Interested Party*" means the party, other than the Society, having an interest in or responsibility for the Ship, product, plant or system subject to classification or certification (such as the owner of the Ship and his representatives, the ship builder, the engine builder or the supplier of parts to be tested) who requests the Services or on whose behalf the Services are requested.

"*Owner*" means the registered owner, the ship owner, the manager or any other party with the responsibility, legally or contractually, to keep the ship seaworthy or in service, having particular regard to the provisions relating to the maintenance of class laid down in Part A, Chapter 2 of the Rules for the Classification of Ships or in the corresponding rules indicated in the specific Rules.

"Rules" in these General Conditions means the documents below issued by the Society:

- (i) Rules for the Classification of Ships or other special units;
- (ii) Complementary Rules containing the requirements for product, plant, system and other certification or containing the requirements for the assignment of additional class notations;
- (iii) Rules for the application of statutory rules, containing the rules to perform the duties delegated by Administrations;
- (iv) Guides to carry out particular activities connected with Services;
- (v) Any other technical document, as for example rule variations or interpretations.

"*Services*" means the activities described in Article 1 below, rendered by the Society upon request made by or on behalf of the Interested Party.

"Ship" means ships, boats, craft and other special units, as for example offshore structures, floating units and underwater craft.

"*Society*" or *"TASNEEF"* means Tasneef and/or all the companies in the Tasneef Group which provide the Services.

"*Surveyor*" means technical staff acting on behalf of the Society in performing the Services.

Article 1

1.1. The purpose of the Society is, among others, the classification and certification of ships and the certification of their parts and components. In particular, the Society:
- (i) sets forth and develops Rules;
- (ii) publishes the Register of Ships;
- (iii) issues certificates, statements and reports based on its survey activities.

1.2. The Society also takes part in the implementation of national and international rules and standards as delegated by various G overnments.

1.3. The Society carries out technical assistance activities on request and provides special services outside the scope of classification, which are regulated by these general conditions, unless expressly excluded in the particular contract.

Article 2

2.1. The Rules developed by the Society reflect the level of its technical knowledge at the time they are published. Therefore, the Society, although committed also through its research and development services to continuous updating of the Rules, does not guarantee the Rules meet state-of-the-art science and technology at the time of publication or that they meet the Society's or others' subsequent technical developments.

2.2. The Interested Party is required to know the Rules on the basis of which the Services are provided. With particular reference to Classification Services, special attention is to be given to the Rules concerning class suspension, withdrawal and reinstatemen t. In case of doubt or inaccuracy, the Interested Party is to promptly contact the Society for clarification.
The Rules for Classification of Ships are published on the Society's website: www.tasneef.ae.

2.3. The Society exercises due care and skill:
- (i) in the selection of its Surveyors
- (ii) in the performance of its Services, taking into account the level of its technical knowledge at the time the Services are performed.

2.4. Surveys conducted by the Society include, but are not limited to, visual inspection and non-destructive testing. Unless otherwise required, surveys are conducted through sampling techniques and do not consist of comprehensive verification or monitoring of the Ship or of the items subject to certification. The surveys and checks made by the Society on board ship do not necessarily require the constant and continuous presence of the Surveyor. The Society may also commission laboratory testing, underwater inspection and other checks carried out by and under the responsibility of qualified service suppliers. Survey practices and procedures are selected by the Society based on its experience and knowledge and according to generally accepted technical standards in the sector.

Article 3

3.1. The class assigned to a Ship, like the reports, statements, certificates or any other document or information issued by the Society, reflects the opinion of the Society concerning compliance, at the time the Service is provided, of the Ship or product subject to certification, with the applicable Rules (given the intended use and within the relevant time frame).
The Society is under no obligation to make statements or provide information about elements or facts which are not part of th e specific scope of the Service requested by the Interested Party or on its behalf.

3.2. No report, statement, notation on a plan, review, Certificate of Classification, document or information issued or given as p art of the Services provided by the Society shall have any legal effect or implication other than a representation that, on the basis of the checks made by the Society, the Ship, structure, materials, equipment, machinery or any other item covered by such document or information meet the Rules. Any such document is issued solely for the use of the Society, its committees and clients or other duly authorised bodies and for no other purpose. Therefore, the Society cannot be held liable for any act made or document issued by other parties on the basis of the statements or information given by the Society. The validity, application, meaning and interpretation of a Certificate of Classification, or any other document or information issued by the Society in connection with its Services, is governed by the Rules of the Society, which is the sole subject entitled to make such interpretation. Any disagreement on technical matters between the Interested Party and the Surveyor in the carrying out of his functions shall be raised in writing as soon as possible with the Society, which will settle any divergence of opinion or dispute.

3.3. The classification of a Ship, or the issuance of a certificate or other document connected with classification or certificati on and in general with the performance of Services by the Society shall have the validity conferred upon it by the Rules of the Society at the time of the assignment of class or issuance of the certificate; in no case shall it amount to a statement or warranty of seaw orthiness, structural integrity, quality or fitness for a particular purpose or service of any Ship, structure, material, equipment or machinery inspected or tested by the Society.

3.4. Any document issued by the Society in relation to its activities reflects the condition of the Ship or the subject of certification or other activity at the time of the check.

3.5. The Rules, surveys and activities performed by the Society, reports, certificates and other documents issued by the Society are in no way intended to replace the duties and responsibilities of other parties such as Governments, designers, ship builders, manufacturers, repairers, suppliers, contractors or sub-contractors, Owners, operators, charterers, underwriters, sellers or intended buyers of a Ship or other product or system surveyed.

These documents and activities do not relieve such parties from any fulfilment, warranty, responsibility, duty or obligation (also of a contractual nature) expressed or implied or in any case incumbent on them, nor do they confer on such parties any right, claim or cause of action against the Society. With particular regard to the duties of the ship Owner, the Services undertaken by the Society do not relieve the Owner of his duty to ensure proper maintenance of the Ship and ensure seaworthiness at all times. Likewise, the Rules, surveys performed, reports, certificates and other documents issued by the Society are intended neither to guarantee the buyers of the Ship, its components or any other surveyed or certified item, nor to relieve the seller of the duties arising out of the law or the contract, regarding the quality, commercial value or characteristics of the item which is the subject of transaction.

In no case, therefore, shall the Society assume the obligations incumbent upon the above-mentioned parties, even when it is consulted in connection with matters not covered by its Rules or other documents.

In consideration of the above, the Interested Party undertakes to relieve and hold harmless the Society from any third party claim, as well as from any liability in relation to the latter concerning the Services rendered.

Insofar as they are not expressly provided for in these General Conditions, the duties and responsibilities of the Owner and Interested Parties with respect to the services rendered by the Society are described in the Rules applicable to the specific Service rendered.

Article 4

4.1. Any request for the Society's Services shall be submitted in writing and signed by or on behalf of the Interested Party. Such a request will be considered irrevocable as soon as received by the Society and shall entail acceptance by the applicant of all relevant requirements of the Rules, including these General Conditions. Upon acceptance of the written request by the Society, a contract between the Society and the Interested Party is entered into, which is regulated by the present General Conditions.

4.2. In consideration of the Services rendered by the Society, the Interested Party and the person requesting the service shall be jointly liable for the payment of the relevant fees, even if the service is not concluded for any cause not pertaining to the Society. In the latter case, the Society shall not be held liable for non-fulfilment or partial fulfilment of the Services requested. In the event of late payment, interest at the legal current rate increased by 1.5% may be demanded.

4.3. The contract for the classification of a Ship or for other Services may be terminated and any certificates revoked at the request of one of the parties, subject to at least 30 days' notice to be given in writing. Failure to pay, even in part, the fees due for Services carried out by the Society will entitle the Society to immediately terminate the contract and suspend the Services.

For every termination of the contract, the fees for the activities performed until the time of the termination shall be owed to the Society as well as the expenses incurred in view of activities already programmed; this is without prejudice to the right to compensation due to the Society as a consequence of the termination.

With particular reference to Ship classification and certification, unless decided otherwise by the Society, termination of the contract implies that the assignment of class to a Ship is withheld or, if already assigned, that it is suspended or withdrawn; any statutory certificates issued by the Society will be withdrawn in those cases where provided for by agreements between the Society and the flag State.

Article 5

5.1. In providing the Services, as well as other correlated information or advice, the Society, its Surveyors, servants or agents operate with due diligence for the proper execution of the activity. However, considering the nature of the activities performed (see art. 2.4), it is not possible to guarantee absolute accuracy, correctness and completeness of any information or advice supplied. Express and implied warranties are specifically disclaimed.

Therefore, except as provided for in paragraph 5.2 below, and also in the case of activities carried out by delegation of Governments, neither the Society nor any of its Surveyors will be liable for any loss, damage or expense of whatever nature sustained by any person, in tort or in contract, derived from carrying out the Services.

5.2. Notwithstanding the provisions in paragraph 5.1 above, should any user of the Society's Services prove that he has suffered a loss or damage due to any negligent act or omission of the Society, its Surveyors, servants or agents, then the Society will pay compensation to such person for his proved loss, up to, but not exceeding, five times the amount of the fees charged for the specific services, information or opinions from which the loss or damage derives or, if no fee has been charged, a maximum of AED5,000 (Arab Emirates Dirhams Five Thousand only). Where the fees charged are related to a number of Services, the amount of the fees will be apportioned for the purpose of the calculation of the maximum compensation, by reference to the estimated time involved in the performance of the Service from which the damage or loss derives. Any liability for indirect or consequential loss, damage or expense is specifically excluded. In any case, irrespective of the amount of the fees charged, the maximum damages payable by the Society will not be more than AED5,000,000 (Arab Emirates Dirhams Five Millions only). Payment of compensation under this paragraph will not entail any admission of responsibility and/or liability by the Society and will be made without prejudice to the disclaimer clause contained in paragraph 5.1 above.

5.3. Any claim for loss or damage of whatever nature by virtue of the provisions set forth herein shall be made to the Society in writing, within the shorter of the following periods: (i) THREE (3) MONTHS from the date on which the Services were performed, or (ii) THREE (3) MONTHS from the date on which the damage was discovered. Failure to comply with the above deadline will constitute an absolute bar to the pursuit of such a claim against the Society.

Article 6

6.1. These General Conditions shall be governed by and construed in accordance with United Arab Emirates (UAE) law, and any dispute arising from or in connection with the Rules or with the Services of the Society, including any issues concerning responsibility, liability or limitations of liability of the Society, shall be determined in accordance with UAE law. The courts of the Dubai International Financial Centre (DIFC) shall have exclusive jurisdiction in relation to any claim or dispute which may arise out of or in connection with the Rules or with the Services of the Society.

6.2. However,

(i) In cases where neither the claim nor any counterclaim exceeds the sum of AED300,000 (Arab Emirates Dirhams Three Hundred Thousand) the dispute shall be referred to the jurisdiction of the DIFC Small Claims Tribunal; and

(ii) for disputes concerning non-payment of the fees and/or expenses due to the Society for services, the Society shall have the right to submit any claim to the jurisdiction of the Courts of the place where the registered or operating office of the Interested Party or of the applicant who requested the Service is located.

In the case of actions taken against the Society by a third party before a public Court, the Society shall also have the righ t to summon the Interested Party or the subject who requested the Service before that Court, in order to be relieved and held harmless according to art. 3.5 above.

Article 7

7.1. All plans, specifications, documents and information provided by, issued by, or made known to the Society, in connection with the performance of its Services, will be treated as confidential and will not be made available to any other party other than the Owner without authorisation of the Interested Party, except as provided for or required by any applicable international, European or domestic legislation, Charter or other IACS resolutions, or order from a competent authority. Information about the status and validity of class and statutory certificates, including transfers, changes, suspensions, withdrawals of class, recommendations/conditions of cl ass, operating conditions or restrictions issued against classed ships and other related information, as may be required, may be published on the website or released by other means, without the prior consent of the Interested Party.

Information about the status and validity of other certificates and statements may also be published on the website or released by other means, without the prior consent of the Interested Party.

7.2. Notwithstanding the general duty of confidentiality owed by the Society to its clients in clause 7.1 above, the Society's c lients hereby accept that the Society may participate in the IACS Early Warning System which requires each Classification Society to provide other involved Classification Societies with relevant technical information on serious hull structural and engineering systems failures, as defined in the IACS Early Warning System (but not including any drawings relating to the ship which may be the specific propert y of another party), to enable such useful information to be shared and used to facilitate the proper working of the IACS Early Warning System. The Society will provide its clients with written details of such information sent to the involved Classification Societies.

7.3. In the event of transfer of class, addition of a second class or withdrawal from a double/dual class, the Interested Party undertakes to provide or to permit the Society to provide the other Classification Society with all building plans and drawings, certificat es, documents and information relevant to the classed unit, including its history file, as the other Classification Society may require for the purpose of classification in compliance with the applicable legislation and relative IACS Procedure. It is the Owner's duty t o ensure that, whenever required, the consent of the builder is obtained with regard to the provision of plans and drawings to the new Society, either by way of appropriate stipulation in the building contract or by other agreement.

In the event that the ownership of the ship, product or system subject to certification is transferred to a new subject, the latter shall have the right to access all pertinent drawings, specifications, documents or information issued by the Society or which has come to the knowledge of the Society while carrying out its Services, even if related to a period prior to transfer of ownership.

Article 8

8.1. Should any part of these General Conditions be declared invalid, this will not affect the validity of the remaining provisions.

EXPLANATORY NOTE TO PART E

1. Reference edition

The reference edition for Part E is this edition effective from 1st January 2015.

2. Effective date of the requirements

2.1 All requirements in which new or amended provisions with respect to those contained in the reference edition have been introduced are followed by a date shown in brackets.

The date shown in brackets is the effective date of entry into force of the requirements as amended by last updating. The effective date of all those requirements not followed by any date shown in brackets is that of the reference edition.

2.2 Item 5 below provides a summary of the technical changes from the preceding edition.

3. Rule Variations and Corrigenda

Until the next edition of the Rules is published, Rule Variations and/or corrigenda, as necessary, will be pub-lished on the Tasneef web site (www.tasneef.ae). Except in particular cases, paper copies of Rule Variations or corrigenda are not issued.

4. Rule subdivision and cross-references

4.1 Rule subdivision

The Rules are subdivided into five parts, from A to E.

Part A: Classification and Surveys

Part B: Hull and Stability

Part C: Machinery, Systems and Fire Protection

Part D: Service Notations

Part E: Additional Class Notations

Each Part consists of:

- Chapters
- Sections and possible Appendices
- Articles
- Sub-articles
- Requirements

Figures (abbr. Fig) and Tables (abbr. Tab) are numbered in ascending order within each Section or Appendix.

4.2 Cross-references

Examples: Pt A, Ch 1, Sec 1, [3.2.1]or Pt A, Ch 1, App 1, [3.2.1]

- Pt A means Part A

The part is indicated when it is different from the part in which the cross-reference appears. Otherwise, it is not indicated.

- Ch 1 means Chapter 1

The Chapter is indicated when it is different from the chapter in which the cross-reference appears. Otherwise, it is not indicated.

- Sec 1 means Section 1 (or App 1 means Appendix 1)

The Section (or Appendix) is indicated when it is different from the Section (or Appendix) in which the cross-reference appears. Otherwise, it is not indicated.

- [3.2.1] refers to requirement 1, within sub-article 2 of article 3.

Cross-references to an entire Part or Chapter are not abbreviated as indicated in the following examples:

- Part A for a cross-reference to Part A
- Part A, Chapter 1 for a cross-reference to Chapter 1 of Part A.

5. Summary of amendments introduced in the edition effective from 1st January 2017

This edition of the Rules for the Classification of Naval Ships contains amendments whose effective date is **1 January2017**.

The date of entry into force of each new or amended item is shown in brackets after the number of the item concerned

This edition of the Rules for the classification of Naval Ships is considered as a reference edition for future amendments.

Description of the amendments
The amendments involve both the framework of the Rules and the technical requirements.

RULES FOR THE CLASSIFICATION OF NAVAL SHIPS

Part E
Additional Class Notations

Chapters 1 2 3 4

CHAPTER 1
MILITARY NOTATIONS (MILITARY)

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Section 2 External Air Blast - “EXT-BLAST“

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Part E
Additional Class Notations

Chapter 1
MILITARY NOTATIONS (MILITARY)

SECTION 1 STRUCTURAL DAMAGE - "STRU-DAM"

1 General

1.1 Scope

1.1.1 The additional class notation **STRU-DAM** is assigned to a ship in order to certify that measures are taken to increase her structural reserve of strength following threat damage to the hull structures from an assigned explosion.

1.1.2 This notation considers the loads coming from internal or external explosion of either a surface-surface missile or a naval gun.

1.2 Field of application

1.2.1 The additional class notation **STRU-DAM** is assigned to ships complying with the requirements of this Section in accordance with Pt A, Ch 1, Sec 2, [7.3.2].

1.3 Condition for the assignment

1.3.1 The assignment of the notation implies that a structural analysis has been carried out for the hull structures and that the ultimate residual strength of the damaged hull complies with the requirements of this Section.

Details of the calculation method and the structural performance achieved, based on the specified loads, will not be published and will be only disclosed to the Naval Authority.

1.4 Documentation to be submitted

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

- the location of the explosions
- the mass and the type of the charge considered
- the equivalent TNT weight for the conventional explosion.

These confidential input data considered for the assignment of the notation are included in the confidential annexes of the class certificate.

In addition, a report on the structural analyses carried out is to be submitted for information, which is to include:

- the description of the ultimate residual strength calculation procedure
- the assumptions made
- the details of the software used and its validation as appropriate
- the results of the strength checks as specified in [2.3].

1.5 Assignment of the notation

1.5.1 If requested by the Naval Authority or by the Shipyard, the **STRU-DAM** notation is assigned by the Society if the acceptance criteria specified in [2.3] are fulfilled.

1.5.2 The structural analyses are to be carried out and the relevant documentation is to be submitted to the Society well in advance of the final structural design so as not to interfere with the class related structural plan approval.

1.6 Definitions

1.6.1 Damage radius

The damage radius is the radius within which the structures, as a consequence of an explosion, are to be considered as not contributing to the hull structural strength. The boundaries of the damage area, including their stiffeners, are also to be considered as not contributing to the strength.

1.6.2 Ultimate bending moment capacities

As specified in Pt B, Ch 6, Sec 3, the ultimate bending moment capacities are defined as the maximum values of the curve of bending moment capacity M versus the curvature χ of the transverse section considered.

2 Structural analysis

2.1 Damage area

2.1.1 The equivalent TNT mass used to determine the damage area is to be specified in the documentation submitted.

The damage radius is to be obtained, in m, from the following formula:

$$r_0 = C \cdot W_i^{\frac{1}{3}}$$

where:

W_i : equivalent weight of TNT, in Kg

C : scaling factor depending on the structure of the ship, to be calculated as shown hereunder:

$$C = 1,61\left(\frac{d}{\sigma_Y t_p}\right)^{0,463}$$

d : distance between decks/longitudinal bulkheads, measured along the direction toward which the radius is calculated

σ_Y : yield stress of the plate materials of structures adjacent to the explosion point

t_p : thickness of the deck/bulkhead in the direction towards which the radius is calculated.

If the damage radius crosses a deck, it is to be reduced to one half.

The analysis is to be carried out assuming that explosions occur:

- in the midship section
- in other transverse sections as requested by the Society on a case by case basis (e.g. where a significant structural discontinuity exist in the longitudinal structural elements of the ships).

For each considered transverse section, the following two locations of the explosion (centre od the damage area) are to be considered:

- intersection between the side shell with the last upper strength deck, see Fig 1
- on the centre longitudinal line plane at mid-distance between the two upper most strength decks, see Fig 2.

Figure 1 : Example of damage radii for case a)

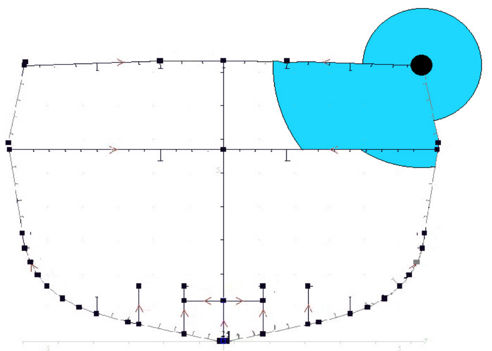
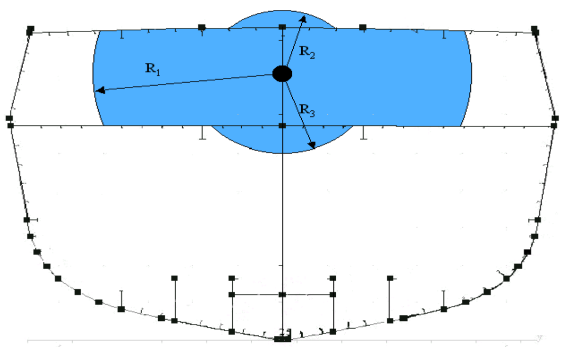


Figure 2 : Example of damage radii for case b)



2.2 Structural assessment

2.2.1 The ultimate residual strength is calculated, as defined in Pt B, Ch 6, App 1, removing all structural components within the damage radius, for the section correspondent to the longitudinal position of the damage radius.

The analysis has to be developed for each threat levels considering the transverse positions specified in [2.1.1], see also Fig 1 and Fig 2.

2.3 Acceptance criteria

2.3.1 For each case, it is to be checked that the hull girder ultimate bending capacity at the relevant transverse section is in compliance with the following formula:

$$\frac{M_{Ud}}{\gamma_r \gamma_m} \geq M$$

where:

M_{Ud} : Ultimate bending moment capacity of the damaged hull transverse section in kNm, in hogging and sagging condition

γ_r, γ_m : Partial safety factors as specified in Pt B, Ch 6, Sec 3, [2.1.1]

M : Bending moment in kNm, defined as follows:

$$M = M_{SW} + 0,6 \cdot M_{WV}$$

M_{SW} : Maximum still water bending moments calculated, in hogging and sagging conditions, as specified in Pt B, Ch 5, Sec 2, [2]

M_{WW} : Maximum vertical wave bending moments calculated, in hogging and sagging conditions, as specified in Pt B, Ch 5, Sec 2, [3] .

SECTION 2 EXTERNAL AIR BLAST - "EXT-BLAST"

1 General

1.1 Scope

1.1.1 The additional class notation **EXT-BLAST** is assigned to a ship whose superstructures have been verified against the loads generated by an external blast due to either a conventional explosion (surface-surface missile) or a nuclear blast.

1.2 Field of application

1.2.1 The additional class notation **EXT-BLAST** is assigned to ships complying with the requirements of this Section in accordance with Pt A, Ch 1, Sec 2, [7.3.3].

The above is completed by the following notations, depending on the type of explosion considered:

-**CONV** : for conventional explosion

-**NUCL** : for nuclear explosion.

1.3 Condition for the assignment

1.3.1 The assignment of the notation implies that a structural analysis has been carried out for the front, side, aft bulkheads and decks of superstructures and deckhouses, for compliance with the requirements of this Section.

Details of the calculation method and the structural performance achieved based on the specified loads will not be published and will be only disclosed to the Naval Authority.

1.4 Documentation to be submitted

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

- the location of the explosions
- the mass and the type of the charge considered
- the equivalent TNT weight for the conventional explosion

These confidential input data considered for the assignment of the notation are included in the confidential annexes of the class certificate.

In addition, a report on the structural analyses carried out is to be submitted for information, which is to include:

- the description of the strength calculation procedure
- the assumptions made
- the details on software used and its validation as appropriate
- the results obtained in terms of stresses and strain as appropriate
- the results of the strength checks as specified in [2.3].

1.5 Assignment of the notation

1.5.1 If requested by the Naval Authority or by the Shipyard, the **EXT-BLAST** notation is assigned by the Society if the acceptance criteria specified in [2.3] are fulfilled.

1.5.2 The structural analyses are to be carried out and the relevant documentation is to be submitted to the Society well in advance of the final design of the superstructures so as not to interfere with the class related structural plan approval.

1.6 Definitions

1.6.1 Conventional explosion

A Conventional explosion is a temporary overpressure caused by an external blast in the free field.

1.6.2 Nuclear explosion

A Nuclear explosion is a temporary overpressure caused by a nuclear explosion occurring outside the vessel.

2 Structural analysis

2.1 Blast threats

2.1.1 General

The loads on the structure generated by a conventional or a nuclear explosion to be used for checking the scantlings of the structure of front, side and aft bulkheads of superstructures and deckhouse, are prescribed, in terms of time dependent equivalent total pressure, from the formulae provided in [2.2] and [2.3].

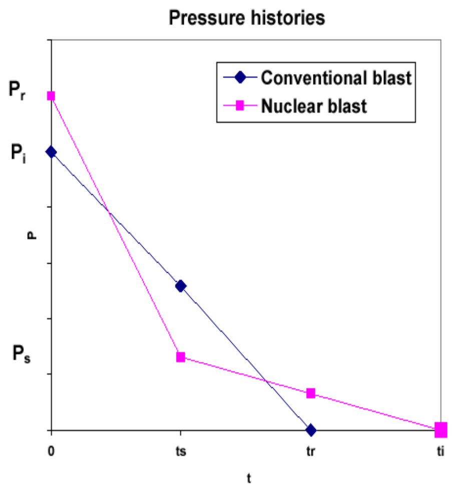
The time history of the equivalent total pressure acting on a surface normal to the direction of the shock propagation is to be assumed as shown in Fig 1:

a) at the time identified with 0 in Fig 1, corresponding to the instant when the shock front hits the solid surface of the structure, the maximum blast overpressure P_i and P_r are to be considered to rise instantaneously to the peak blast overpressure;

b) the overpressure time history should be taken as:

- for a conventional blast, linearly decreasing until zero value at the time t_i
- for a nuclear blast, bi-linearly decreasing until value P_s at time t_s and value 0 at time t_i.

Figure 1 : Time-history of the total equivalent pressure



2.1.2 Conventional blast

The characteristics of the total equivalent pressure due to a conventional blast are:

P_i : peak pressure, in Pa

I_i : impulse, in Pas

t_r : duration, in s

and are given in Fig 2 as a function of the reduced radius $\bar{R}$

$$\bar{R} = \frac{R}{W^{\frac{1}{3}}}$$

where:

W : equivalent weight of TNT, in [Kg]

R : distance in m, of the solid structure from the center of the explosion.

2.1.3 Nuclear blast

The characteristics of the total equivalent pressure due to a nuclear-blast are:

P_r : peak reflected pressure, in Pa

$$P_r = 2 \cdot \frac{P_i}{P_0}\left(\frac{7 + 4\frac{P_i}{P_0}}{7 + \frac{P_i}{P_0}}\right)$$

P_s : peak stagnation pressure, in Pa

$$P_s = P_i + C_d \cdot P_d$$

t_i : overpressure duration, in second

$$t_i = t'_i \cdot W^{\frac{1}{3}}$$

where:

C_d : drag coefficient of the structure given in Tab 1

P_i : peak pressure, in Pa

P_0 : atmospheric pressure at ambient temperature, in Pa

P_d : dynamic pressure, in Pa

t'_i : overpressure duration for 1-MT weapon

are given in Fig 3 as function of the equivalent ground zero distance R:

$$\bar{R} = \frac{R}{W^{\frac{1}{3}}}$$

W : equivalent weapon size in megnaton MT

R : horizontal distance from explosion location (effective ground zero distance), in m

The time until the effect of wave reflection disappear and reaches the stagnation pressure is to be obtained, in s, from the following formula:

$$t_s = \frac{3 \cdot S_c}{U}$$

where:

S_c : smaller length, in Fig 4

U : velocity, in m/s, of the shock front

$$U = U_s\left(1 + \frac{6P_i}{7P_0}\right)^{\frac{1}{2}}$$

U_s : sound speed in air, in m/s

Table 1

Superstructures face	C_d
Front and Rear	1,0
Top of sides	0,4
Masts and funnels	0,75

Figure 2 : Conventional Blast: overpressure, impulse and duration

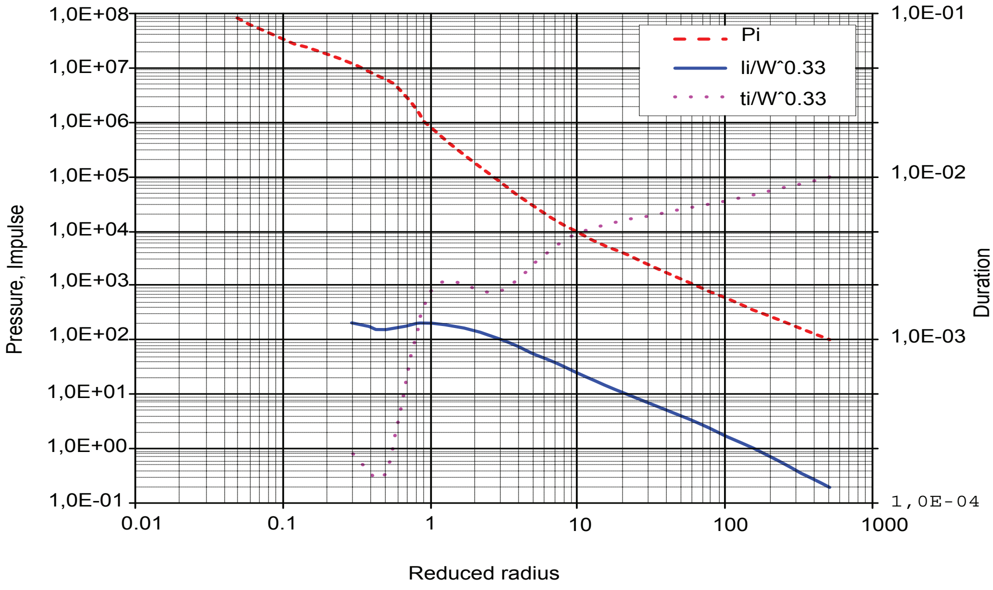
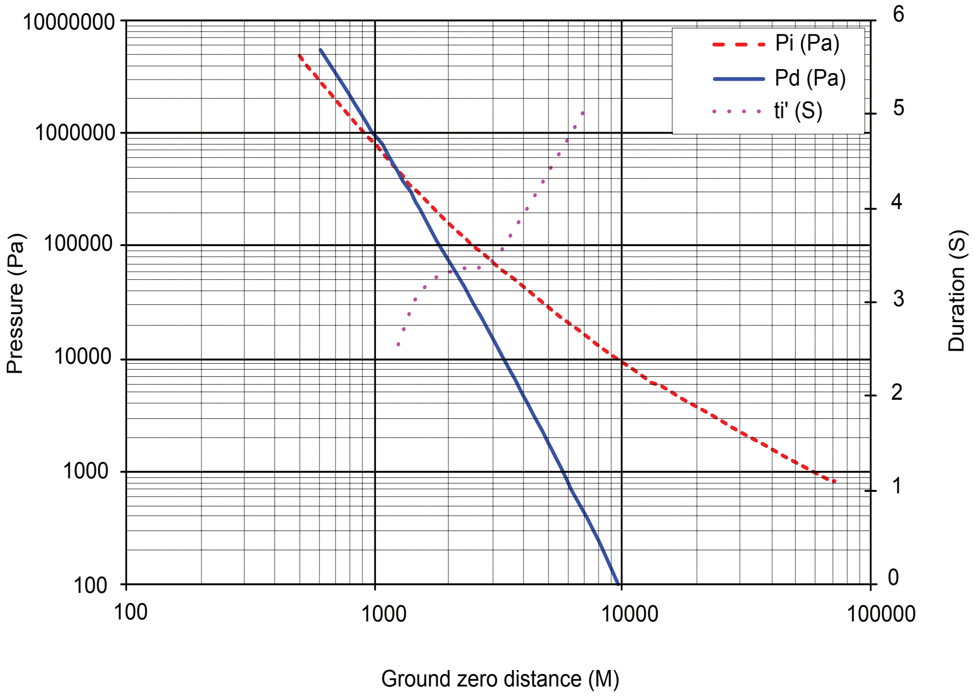


Figure 3 : Nuclear blast: overpressure, dynamic pressure and duration



2.2 Structural assessment

2.2.1 General

In order to demonstrate compliance with the requirements in [2.3], a structural assessment of primary supporting members is to be carried out based on direct calculations of the response to the loads defined in [2.1].

The structural assessment is to be carried out by means of non-linear Finite Element Analyses taking into account also the mechanical characteristics in plastic field. Results of the analyses are considered by the Society on a case-by-case basis.

Methods of analysis alternative to non-linear Finite Element may be accepted by the Society on a case-by-case basis.

2.2.2 Additional requirements for the EXT-BLAST(NUCL) notation

In order to grant the **EXT-BLAST(NUCL)** notation, the primary supporting member analysis is to be carried out by means of a global model of superstructures. The load to be applied is the overpressure from the nuclear explosion defined in [2.1.3].

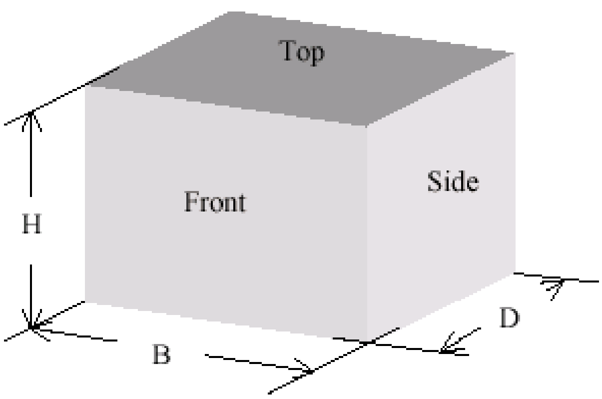
The time histories of the resulting loads are calculated as follows:

a) The sides of the superstructure simplified as shown in Fig 4 are subject to the total pressure according to the following assumption:

- front face: when the blast wave at time t_0 hit on the surface normal to the shock travel, the P_r value has to be used since to decrease at the P_s value at time ts
- sides and top faces: the peak pressure P_s is applied with drag coefficient of Tab 1, as applicable, with a delay time t_t = D/U
- rear face: the peak pressure Ps is applied at time t_r=t_t +t_d (when the shock front reaches the rear face and after a growing time t_d=4 S_c/U, with S_c as defined above).

b) The total loads-time variation is given at any time by the vector sum of the pressure integral acting on each side.

Figure 4



2.3 Acceptance criteria

2.3.1 General

It is to be checked that the maximum plastic strain of the modeled structures does not exceed the strain corresponding to the maximum stress in the (σ, ε) curve of the material.

2.3.2 Plating

These requirements apply to plates with or without ordinary stiffeners of bulkheads and decks of the superstructures boundaries.

The thickness, in mm, of plating of front, side, aft bulkheads and decks of superstructures is to be not less than:

$$t = \frac{F_p \cdot I_i \cdot R_f}{S\sqrt{\rho_i \cdot \sigma_y}}$$

F_p : plate aspect ratio factor, given in Tab 2, as a function of the edge to length ratio a/b of the relevant panel

$$R_f = 2 \cdot \frac{7P_0 + 4P_i}{7P_0 + P_i}$$

$$\rho_i = \rho_0 \cdot \frac{7 + 6\frac{P_i}{P_0}}{7 + \frac{P_i}{P_0}}$$

$$S = \frac{t}{t + \frac{A_s}{l}}$$

for stiffened plates (=1 for not stiffened plate)

I_I : value taken from Fig 2

P_0 : atmospheric pressure at T_0, in Pa

ρ_0 : air standard density at temperature T_0 in [Kg/m^3]

T_0 : ambient air temperature

σ_y : yield stress in Pa

P_i : is the equivalent total pressure, in kN/m^2, defined above

A_s : total area, in mm^2 of the stiffeners

l : panel length, in mm, normal to the stiffeners direction

Table 2

A/b	F_p
1	0,60
2	0,92
3	0,98
≥4	1,00

2.3.3 Primary supporting members

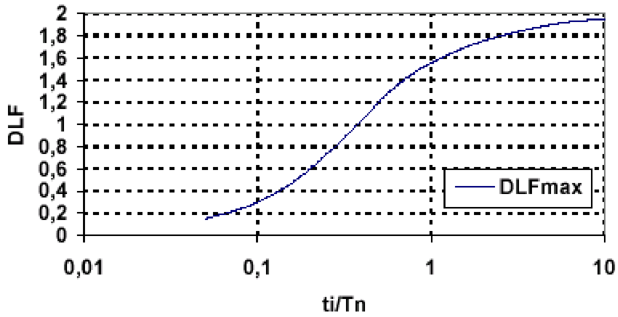
The strength of the primary supporting member is to be such that, where the maximum plastic deflection Z_{max} is reached, the maximum plastic strain of the structure does not exceed the strain corresponding to the maximum stress in the (σ, ε) curve of the structural material.

Where deemed acceptable by the Society, primary supporting members may be checked by using the formulae in Pt B, Ch 7, Sec 3, [3.8], as applicable, taking into account a dynamic load factor (DLF), applied to the peak pressure defined in [2.1.2] and [2.1.3].

The dynamic load factor is defined as the maximum ratio of the dynamic to the static deflection that results from the static application of the peak pressure.

In absence of a direct dynamic calculation of DLF, the value for a one-degree elastic systems subjected to a suddenly applied triangular pulse is given in Fig 5, versus the ratio of the pressure duration time and the natural period Tn of the structure. As an alternative the conservative value DLF=2 may be used.

Figure 5



SECTION 3 INTERNAL AIR BLAST - "INT-BLAST"

1 General

1.1 Scope

1.1.1 The additional class notation **INT-BLAST** is assigned to a ship in order to certify that measures are taken to limit blast damage following an assigned internal explosion.

This notation considers the loads coming from an internal explosion of surface-surface missile.

1.2 Field of application

1.2.1 The additional class notation **INT-BLAST** is assigned to ships complying with the requirements of this Section.

The number of safety area n completes the above notation in accordance with Pt A, Ch 1, Sec 2, [7.3.4].

1.3 Condition for the assignment

1.3.1 The assignment of the notation implies that a structural analysis has been carried out for the boundary of each safety area (bulkheads and decks), for compliance with the requirements of this Section.

Details of the calculation method and the structural performance achieved based on the specified loads will not be published and will be only disclosed to the Naval Authority.

1.4 Documentation to be submitted

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

- the identification of the "safety areas"
- the location of the explosions
- the mass and the type of the charge considered
- the equivalent TNT weight for the conventional explosion

These confidential input data considered for the assignment of the notation are included in the confidential annexes of the class certificate.

In addition, a report on the structural analyses carried out is to be submitted for information, which is to include:

- the description of the strength calculation procedure
- the assumptions made
- the details on software used and its validation as appropriate
- the results obtained in terms of stresses and strain as appropriate
- the results of the strength checks as specified in [2.3].

1.5 Assignment of the notation

1.5.1 If requested by the Naval Authority or by the Shipyard, the **INT-BLAST** notation is assigned by the Society if the acceptance criteria specified in [2.3] are fulfilled.

1.5.2 The structural analyses are to be carried out and the relevant documentation is to be submitted to the Society well in advance of the final structural design so as not to interfere with the class related structural plan approval.

1.6 Definitions

1.6.1 Internal Blast

An internal blast is the loads due to the direct and reflected air blast waves caused by a conventional explosion in a confined field.

1.6.2 Safety Area

A Safety Area is an area such that vital components located inside this area are protected and are able to maintain their functionality after an explosion occurring outside this area.

If double or multiple bulkheads are used to protect a safety area, they are to be included in the same area and the explosion is to be considered to occur outside them.

2 Structural analysis

2.1 Blast threats

2.1.1 The load developed by the internal blast to be used for the checks of bulkheads and decks is given, as equivalent quasi static pressure in Pa, by the following formula:

$$P_{qs} = 2,25\left(\frac{W}{V}\right)^{0,72}$$

where:

W : equivalent weight of TNT, in Kg

V : volume of compartment, in m^3

A step function is to be assumed to represent the time-variation of the equivalent quasi-static pressure inside the compartment where the explosion is considered to occur.

2.2 Structural assessment

2.2.1 General

The requirements of this Section apply to the structural scantlings of those bulkheads and decks that are the boundary of the considered safety areas and which may or may not contribute to the strength of the ship.

In order to demonstrate compliance with the requirements in [2.3], a structural assessment of primary supporting members is to be carried out based on direct calculations of the response to the loads defined in [2.1].

The structural assessment is to be carried out by means of non-linear Finite Element Analysis taking into account also the mechanical characteristics in the plastic field. Results of the analyses are considered by the Society on a case-by-case basis.

Methods of analysis alternative to non-linear Finite Element may be accepted by the Society on a case-by-case basis.

2.2.2 Critical structures

For each boundary of each considered safety area, the analysis is to be carried out for the compartment that:

- is located on the perimeter of the safety area,
- has the largest charge size to compartment volume ratio.

If the boundary of the safety area is a double bulkhead and if the first bulkhead (the external one with respect to the safety area) can not sustain the blast load given in the strength of the remaining bulkhead is to be checked considering the load obtained by using the same formula in [2.1] assuming V equal to the sum of the volumes of the compartments put in communication by the failure of the first bulkhead.

The same criterion is to be used if more than two bulkheads are used.

2.3 Acceptance criteria

2.3.1 General

It is to be checked that:

a) the maximum plastic strain of the modelled structures does not exceed the strain corresponding to the maximum stress in the (σ, ε) curve of the material

b) the maximum displacements do not compromise the structural integrity or water/gas-tight integrity of the bulkheads/decks.

2.3.2 Plating

These requirements apply to plates with or without ordinary stiffeners of safety area boundaries.

The thickness, in mm, of plating is to be not less than:

$$t = 10^3 \cdot \frac{P_{qs} \cdot F_p}{S \cdot \sigma_y}$$

where:

:

F_p : plate aspect ratio factor, given in Tab 1, as function of the edge length ratio a/b of the relevant pane

$$S = \frac{t}{t + \frac{A_s}{l}}$$

for stiffened plates (=1 for not stiffened plate)

σ_y : yield stress, in Pa

A_s : total area, in mm², of the stiffeners

l : panel length, in mm, normal to the stiffeners direction

Table 1

a/b	F_p
1	0,60
2	0,92
3	0,98
≥4	1,00

2.3.3 Primary supporting members

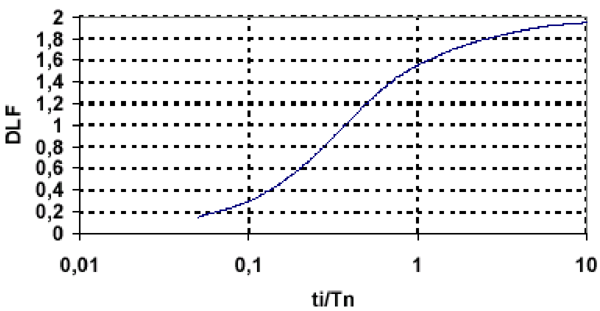
The strength of the primary supporting member is to be such that, where the maximum plastic deflection z_{max} is reached, the maximum plastic strain of the structure does not exceed the strain corresponding to the maximum stress in the (σ, ε) curve of the structural material.

Where deemed acceptable by the Society, primary supporting members may be checked by using the formulae in Pt B, Ch 7, Sec 3, as applicable, taking into account a dynamic load factor (DLF), applied to the quasi static pressure defined in [2.1.1].

The dynamic load factor is defined as the maximum ratio of the dynamic to the static deflection that results from the static application of the peak pressure.

In absence of a direct dynamic calculation of DLF, the value for a one-degree elastic systems subjected to a suddenly applied triangular pulse is given in Fig 1, versus the ratio of the pressure duration time, t_1 and the natural period Tn of the structure. As an alternative the conservative value DLF=2 may be used.

Figure 1



SECTION 4 FRAGMENTATION PROTECTION - "FRAGM"

1 General

1.1 Scope

1.1.1 The additional class notation **FRAGM** is assigned to a ship in order to certify that measures are taken to limit damage following an assigned explosion.

1.2 Field of application

1.2.1 The additional class notation **FRAGM** is assigned assigned to ships complying with the requirements of this Section.

The number of safety areas completes the above notation in accordance with Pt A, Ch 1, Sec 2, [7.3.5].

1.3 Condition for the assignment

1.3.1 The assignment of the notation implies that a structural analysis has been carried out for the boundary of each safety area (bulkheads and decks) for compliance with the requirements of this section.

Details of the calculation method and the structural performance achieved, based on the specified loads, will not be published and will be only disclosed to the Naval Authority.

1.4 Documentation to be submitted

1.4.1 Documentation to be submitted for approval

When a non-structural ballistic protection is fitted, the relevant plan is to be submitted for approval, in addition to the plans and documents listed in Pt B, Ch 1, Sec 3.

1.4.2 Documentation to be submitted for information

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

a) the identification of the "safety areas";

b) the characteristics of the "design fragment" considered:
   - velocity,
   - mass,
   - type (natural/predetermined);

c) if the type identifies a fragment originated by a predetermined fragmentation, the characteristics of the fragment are to include:
   - shape,
   - main dimensions.

These confidential input data considered for the assignment of the notation are included in the confidential annexes of the class certificate.

In addition, a report on the structural analyses carried out is to be submitted for information, which is to include:

- the description of the calculation procedure, if different from the one described in [2] and [3],
- the assumptions made,
- the details of the test performed, if any
- the summary of the results obtained.

1.5 Assignment of the notation

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

1.5.2 The structural analyses are to be carried out and the relevant documentation is to be submitted to the Society well in advance to the final structural design so as not to interfere with the class related structural plan approval.

1.6 Definitions

1.6.1 Safety Area

A safety area is an area such that vital component located inside this area are protected and are able to maintain their functionality after an explosion occurring outside this area.

If double or multiple bulkheads are used to protect a safety area, they are to be included in the same area and the explosion is to be considered to occur outside them.

1.6.2 Natural Fragmentation

The natural fragmentation is the fragmentation of the casing of a warhead, a bomb or a projectile, which occurs as a consequence of the explosion of its internal charge without any predetermination of the shape and weight of the relevant fragments.

1.6.3 Predetermined Fragmentation

The predetermined fragmentation is the fragmentation of the casing of a pre-fragmented warhead, bomb or projectile, which has been designed to generate fragments having a predetermined shape and weight.

Details on pre-fragmentation to be considered in the analysis are to be provided by the Naval Authority.

1.6.4 Design Fragment

The design fragment is the fragment the boundary bulkheads of the safety zone are designed to resist to.

2 Single plate bulkheads and decks

2.1 Structural analysis

2.1.1 The requirements of this Section apply to the scantling of plating of bulkheads and decks that may or may not contribute to the strength of the ship.

The check of the thickness of a bulkhead or deck forming the boundary of a "safety area" is to be carried out in accordance to the formulas given in [2.2] and [2.3] depending on the type of fragment considered.

Alternative methods based on experimental results may be accepted by the Society on a case by case basis.

2.2 Natural fragmentation

2.2.1 If the "design fragment" is a consequence of a natural fragmentation, the thickness for plating of bulkheads and decks forming the boundary of a "safety area" is to be not less than, in mm:

$$t_e = 2,5 \cdot 10^{-C_1/C_2} M^{-(2/3 + C_3/C_2)} V_s^{(1 - C_4)/C_2}$$

where:

M : mass, in g, of "design fragment"

V_s : velocity, in m/s, of the "design fragment".

The residual velocity V_r, in m/s and mass M_r, in g, of the fragment after the penetration of the plate, if required by the multiple penetration checks according to [3], may be calculated by means of the following formulas:

$$V_r = V_s - 10^{(C_1 - 0,398C_2)} t^{C_2} M^{(C_3 + 2C_2/3)} V_s^{C_4}$$

$$M_r = M - 10^{(C_5 - 0,398C_6)} t^{C_6} M^{(C_7 + 2C_6/3)} V_s^{C_8}$$

where:

t : thickness, in mm, of the considered plate.

The constants C_1, C_2,... C_8 depend on the type of material in accordance with Tab 1 and Tab 2.

Table 1

	C_1	C_2	C_3	C_4
Mid steel and high tensile strength steel	2,801	0,889	-0,945	0,019
Tempered steel	2,877	0,889	-0,945	0,019
Surface hardened steel	1,631	0,674	-0,791	0,434

Table 2

	C_5	C_6	C_7	C_8
Mid steel and high tensile strength steel	-2,616	0,138	0,835	0,761
Tempered steel	-3,017	0,346	0,629	0,880
Surface hardened steel	-1,768	0,234	0,744	0,483

2.3 Predetermined fragmentation

2.3.1 If the "design fragment" is a consequence of a pre-fragmented war-head, bomb or projectile, the thickness t_e in mm, of the plating of bulkheads and decks forming the boundary of a "safety area" is to be such as to satisfy the following formula:

$$V_s = 4 \cdot 10^3 K_1 \sqrt{t_e K_2 - 1 + e^{-t_e K_2}}$$

where:

V_s : velocity, in m/s of the "design fragment"

$$K_1 = 1,177 \frac{K^{0,525}}{\rho_F^{0,5}}$$

$$K_2 = \frac{1}{2}\left(\frac{\pi}{K}\right)^{1/2}\left(\frac{\rho_F}{M}\right)^{1/3}$$

The constant K, shape factor of the fragment, is to be such that:

K : $\dfrac{\text{External surface of the fragment}}{(\text{Volume of the fragment})^{2/3}}$

M : mass, in g, of the "design fragment"

ρ_F : density, in g/m³ of the "design fragment".

The residual velocity Vr, in m/s, of the fragment after the penetration of the plate if required by the multiple penetration checks according to [3] may be calculated by means of the following formula:

$$V_r = A(V_s^{7,81} - V_e^{7,81})^{0,128}$$

where:

$$A = \frac{1}{1 + 7,81 t K_3^2}$$

$$K_3 = \frac{2K^{3/2}}{\rho_F \sqrt{\pi}}$$

3 Multiple penetrations

3.1 Structural analysis

3.1.1 In order to evaluate the capability to resist to the "design fragment" of bulkheads or decks built with two or three plates, it is necessary to apply the formulae in [2.2] or [2.3] to evaluate the residual velocity and mass, if applicable, of the "design fragment" after the penetration of the first plate, and to apply the same procedure in [2.2] or [2.3] to check the other plates.

As an alternative, graphics are available, like those reported in Fig 1, for equally spaced steel plates of the same thickness, subject to penetration of steel regular shaped fragments, to determine the thickness of each plate as a function of the impact velocity and fragment mass.

Figure 1 : Triple plate

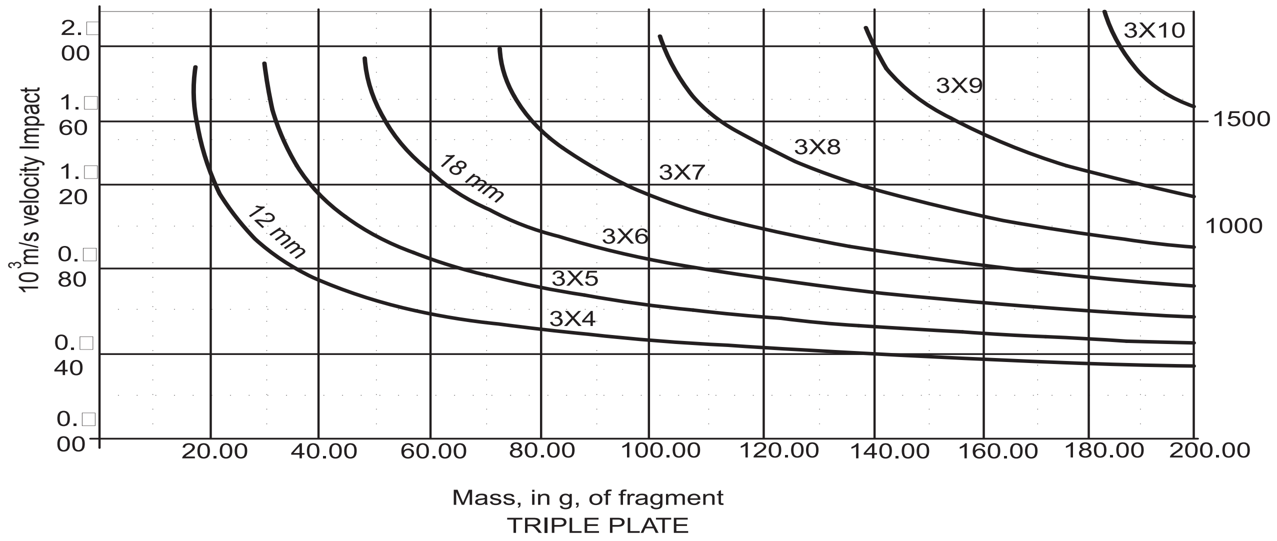
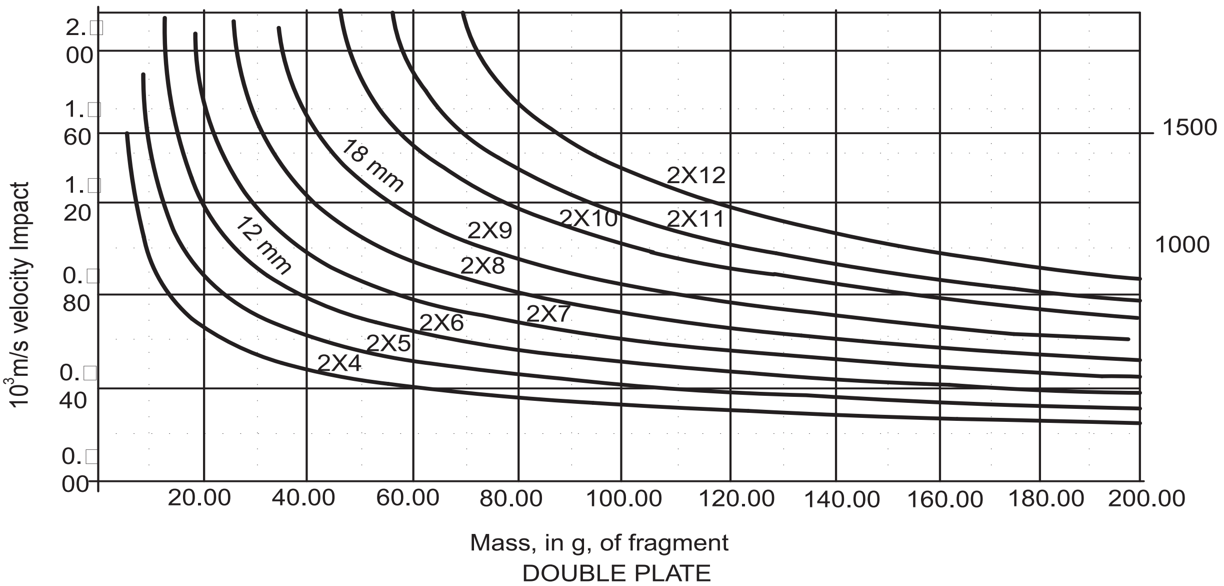


Figure 2 : Double plate



SECTION 5 AIR EXPLOSION - "AIR-EX"

1 General

1.1 Scope

1.1.1 The additional class notation **AIR-EX** is assigned to a ship in order to certify that measures are taken to increase her survivability following threat damage to the structures and components from an assigned air non-contact explosion.

1.2 Field of application

1.2.1 The additional class notation **AIR-EX** is assigned assigned to ships complying with the requirements of this Section in accordance with Pt A, Ch 1, Sec 2, [7.3.6].

The above is completed by the following notations, depending on the specified performance assured:

-**FLOAT** : for buoyancy and structural integrity

-**FUNCT** : for a performance that is to be specified by the Naval Authority (e.g. mobility, air self defense, air defense, anti submarine and antisurface warfare).

1.3 Condition for the assignment

1.3.1 The assignement of the notation implies that a vulnerability analysis has been carried out to demonstrate that the ship maintains her capability to operate specified performances, on the basis of the requirements of this Section.

Details of the methods and the performances achieved, based on the specified assumptions, will not be published and will be only disclosed to the Naval Authority.

1.4 Documentation to be submitted

1.4.1 Documentation to be submitted for approval

In the case of **AIR-EX-FUNCT** notation relevant to certain performances, the topological and detail functional schemes, through which the performances are defined, are to be submitted for approval. The functional schemes are to indicate the overall dimensions of each component and its position.

1.4.2 Documentation to be submitted for information

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

a) The characteristics of the air weapon/weapons for which the notation is assigned:
   - Warhead weight, in kg
   - Charge weight, in kg
   - Equivalent TNT weight, if different from charge weight, in kg
   - Speed of the projectile/warhead
   - Thickness of mid steel the warhead/projectile is able to penetrate, in mm
   - Type of fragmentation (natural/pre-fragmented), if pre-fragmented also the fragments distribution (weights, velocities and angles)
   - Delay after impacct, in s.

b) The probabilistic hit distribution (along the three coordinate axis).

c) The performances that the ship is to remain capable to operate, at a certain probability level, defined through their functional schemes. All the components included in a functional scheme are to be considered as vital for the relevant performance.

d) The probability levels of the performances to remain operational, depending on the weapon considered.

These confidential input data considered for the assignment of the notation are included in the confidential annexes of the class certificate.

In addition, a report on the vulnerability analyses carried out is to be submitted for information, which is to include:

- the theoretical background of the methodology adopted and the description of the calculation procedure
- the assumptions made
- the details of the software used and its validation as appropriate
- the summary of the results obtained, in terms of probability of fulfil an assigned performance.

1.5 Assignment of the notation

1.5.1 If requested by the Naval Authority or by the Shipyard, the **AIR-EX** notation is assigned by the Society if the acceptance criteria specified in this section are fulfilled.

1.5.2 The vulnerability analysis is to be carried out and the relevant documentation is to be submitted to the Society well in advance of the final design of the ship so as not to interfere with the class related plan approval.

2 Vulnerability analysis

2.1 General

2.1.1 The vulnerability analysis is to be carried out by means of a vulnerability code, accepted by the Society and able to calculate the probability that an assigned performance remains operational after an external air attack has occurred.

2.2 Vulnerability code

2.2.1 The code is to be able to perform a probabilistic (or semi-probabilistic) vulnerability analysis, that is to evaluate the capability of the ship to operate assigned performances (**FLOAT** and / or **FUNCT**, as defined in [1.2]), in a probabilistic way.

2.2.2 In order to perform the above-mentioned vulnerability analysis the code is to be capable to model the ship according to the following requirements:

a) modelling of the ship structures by defining their structural and physical characteristics;

b) modelling of the systems of the ship (necessary to operate the assigned performances) by means of the characteristics of their components, as:

- physical positioning of the components on board,
- assembling the components to define the functional schemes of the systems,
- assembling the systems and/or the components to define the performances functional schemes (see Fig 1).

c) evaluate the air weapons effects on the ship structures and on components, at least those due to blast and fragmentation, by means of a deterministic approach, given the weapon's characteristics;

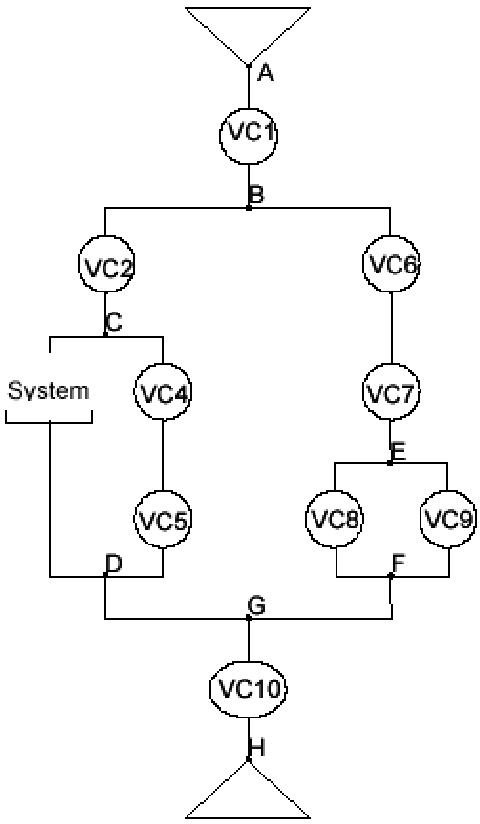
d) evaluate the probabilistic effects of the weapon on performances given a probabilistic spatial hit distribution, defined by the Naval Authority.

The above scheme is just indicative of the characteristics of a generic vulnerability code; variation on the approach of codes used by different Naval Authorities are be subject to the evaluation and approval of the Society.

2.3 Acceptance criteria

2.3.1 The probability, obtained from the vulnerability analysis, that each assigned performance remains operational after an external air attack has occurred, is to be greater than the corresponding probability levels, defined by the Naval Authority.

Figure 1 : Performance functional scheme



SECTION 6 SHOCK ENHANCEMENT - "SHOCK"

1 General

1.1 Scope

1.1.1 The additional class notation **SHOCK** is assigned to a ship in order to certify that measures are taken to increase her survivability following threat damage to the structures and components 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 Field of application

1.2.1

The additional class notation SHOCK is assigned assigned to ships complying with the requirements of this Section in accordance with Pt A, Ch 1, Sec 2, [7.3.7].

The above is completed by the following notations, depending on the specified performance assured:

- -**FLOAT** : for buoyancy and structural integrity
- -**WHIP** : for global structural resistance under bending and vibrations due to whipping
- -**FUNCT** : for a performance that is to be specified by the Naval Authority (e.g. mobility, air self defence, air defence, anti submarine and antisurface warfare).

1.3 Condition for the assignment

1.3.1

The assignment of the notation implies that a detailed structural analysis or a test have been carried out on structures and components, identified in [2], for compliance with the requirements of this Section taking also into account the dynamic vertical bending and vibrations that can be induced by the assigned underwater non-contact explosion.

Details of the calculation 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.

For the assignment of the **SHOCK-FUNCT** notation the requirements of the **SHOCK-FLOAT** and **SHOCK-WHIP** are to be complied with (see [2.2] and [2.3]).

1.4 Documentation to be submitted

1.4.1 Documentation to be submitted for approval

In the case of the **SHOCK-FUNCT**, notation relevant to certain performances, the topological and detail functional schemes, through which the performances are defined, are to be submitted for approval.

The functional schemes are to indicate the overall dimensions of each component and its position.

1.4.2 Documentation to be submitted for information

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

the HSF (hull shock factor), as defined in [1.6.2]; the HSF used for the assignment of **SHOCK-FUNCT** and **SHOCK-WHIP** notations may differs from the HSF used for the assignment of **SHOCK-FLOAT** notation.

- the mass W, in kg, of equivalent TNT, for each performance.

the "Shock Catalog", which is to include the list of components to be calculated and those to be tested (only for **SHOCK-FUNCT**).

the performances that the ship is to remain capable to operate, defined in terms of services and systems that are to be available with the indication of the performance level to be attained (full operability/degraded operability) (only for **SHOCK-FUNCT**).

- the list of machinery and equipments which are to be installed on resilient mounting with indication of the maximum accelerations and displacements expected (only for **SHOCK-FUNCT**).

These confidential input data considered for the assignment of the notation are included in the confidential annexes of the class certificate.

In addition, a report on the shock analyses, whipping analyses and shock tests carried out is to be submitted for information, which is to include:

- the description of the calculation procedure
- the assumptions made
- the details of the software used and its validation as appropriate
- the summary of the results obtained
- the test specifications.

1.5 Assignment of the notation

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

1.5.2 The structural analyses are to be carried out and the relevant documentation is to be submitted to the Society well in advance to the final design of the structures so as not to interfere with the class related structural plan approval.

1.6 Definitions

1.6.1 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.

1.6.2 Hull Shock Factor

The Hull Shock Factor HSF, is defined as:

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

where:

W : charge mass, in kg, of TNT equivalent

R : distance, in m, between the centre 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 water line and the longitudinal plane of symmetry of the ship (see Fig 1), when specified by the Naval Authority, distance R may be calculated in accordance with STANAG 4137.

1.6.3 Whipping

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

1.6.4 Gas Bubble

A gas bubble is the globe containing the gaseous products of the explosions that induce a quasi-periodic load with a frequency of expansion and contraction able to excite the first vertical natural frequency of the ship's hull.

2 SHOCK Structural analysis

2.1 Shock threats

2.1.1 Free field pressure

For any point in the fluid domain, the time history of the pressure associated with the shock wave generated by an underwater non-contact explosion is obtained, in MPa, from the following formulas:

$$P_F = P_{max} e^{-\frac{t}{\vartheta}}$$

P_{max} : is the maximum pressure at the distance R from the explosion center:

$$P_{max} = 52,1\left(\frac{W^{1/3}}{R}\right)^{1,18}$$

for

$$\frac{R}{W^{1/3}} \geq 1$$

$$P_{max} = 39,15\left(\frac{W^{1/3}}{R}\right) + 12,68\left(\frac{W^{1/3}}{R}\right)^2 + 0,27\left(\frac{W^{1/3}}{R}\right)^2$$

for

$$1 > \frac{R}{W^{1/3}} \geq 0,65$$

$$P_{max} = 55,75\left(\frac{W^{1/3}}{R}\right)^{1,15}$$

for

$$0,65 > \frac{R}{W^{1/3}} \geq 0,3$$

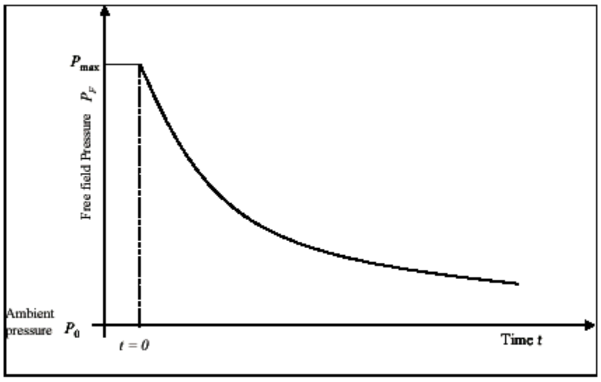
ϑ : is the decay constant, in ms, defined as:

$$\vartheta = 0,09W^{1/3}\left(\frac{W^{1/3}}{R}\right)^{-0,185}$$

t : is the time; (at t=0 the maximum pressure is obtained).

The time history of the free field pressure at a certain distance from the centre of the explosion is shown in Fig 2.

Figure 1 : Shock wave. Free field pressure-time history



The energy, per unit area, of the shock wave is given by:

$$E_w = \frac{P_{max}^2 \vartheta}{2\rho_w C}$$

where:

ρ_w : is the sea water density = 1025 kg/m^3

C : is the speed of acoustic wave in sea water = 1500 m/s

2.1.2 Load pressure

The effective pressure P_L acting on the structures due to the free field pressure P_F, is given by:

$$P_L = 2P_F$$

where P_F, is defined in [2.1.1].

2.2 Criteria for the assignment of the notation SHOCK-FLOAT

2.2.1 Structural assessment

This requirement implies that, for the **HSF** corresponding to the notation **FLOAT**, the ship's bottom does not fail under the load due to shock wave striking on it.

a) Plating

The maximum plastic permanent deflection of bottom platings due to the impact of the shock wave is to be evaluated using the following equations:

$$z_{max} = \sqrt{\frac{2E_d}{K}}$$

where:

E_d : is the kinetic energy of the shock wave that goes into the plastic deformation of the panel:

$$E_d = 4E_w\eta^{\frac{1+\eta}{1-\eta}}$$

with:

$$\eta = \frac{\rho_s t}{\rho_w c \vartheta}$$

K : is the plastic constant of the unstiffened panel:

$$K = \frac{72}{5}\left(\frac{1}{a^2} + \frac{1}{b^2}\right)\sigma_y t$$

with:

a, b : dimensions, in mm, of the panel

t : thickness, in mm, of the panel

ρ_s : density, in kg/m^3 of the material.

σ_y : yield stress, in Pa.

b) Stiffened panels

A direct calculation of the stiffened panels of the ship's bottom is to be carried out by a dynamic non-linear analysis applying the pressure load time-history defined in [2.1.1].

2.2.2 Acceptance criteria

a) **Plating**

The thickness of the bottom plating is to be such that, where the maximum plastic deflection Zmax is reached, the maximum plastic strain of the panel does not exceed the strain corresponding to the maximum stress in the (σ, ε) curve of the plate material.

b) **Stiffened panels**

Based on a dynamic non-linear analysis, the maximum plastic strain of the stiffened panels of the bottom is not to exceed the strain corresponding to the maximum stress in the (σ, ε) curve of the plate material.

c) **Sea chests**

Sea chests are to be of a type tested to external pressure. The pressure test is to be defined on the basis of the relevant HSF. Sea chests are to remain watertight after the test has been carried out.

2.3 SHOCK-WHIP

2.3.1 General

The parameters associated with the gas bubble pulse caused by an underwater explosion occurring at a depth d and a distance R (see Fig 2) can be evaluated using the following formulae:

- Maximum bubble radius R_{max}, in m:

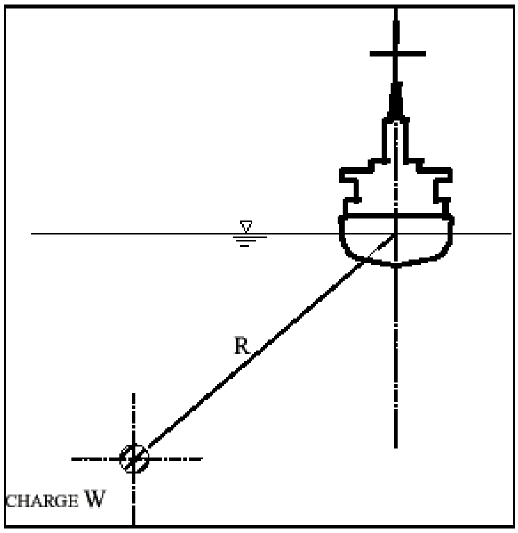
$$R_{MAX} = 3,382\left(\frac{\dot{W}}{d+10}\right)^{1/3}$$

where d is the depth of the change, in m

- Duration of the first pulse t_1, in s, that can be assumed to be the period of the pulsating gas bubble:

$$t_1 = 2,064\frac{W^{1/3}}{(d+10)^{5/6}}$$

Figure 2 : Underwater explosion geometry



2.4 Verification of whipping effect

2.4.1 General

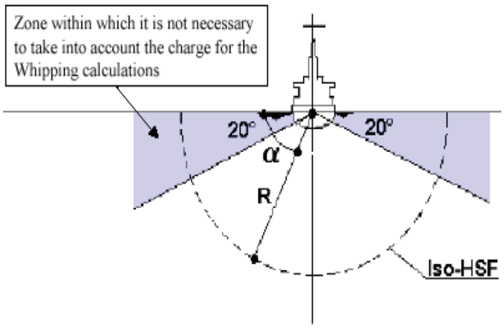
The structural assessment analysis outlined in the following is to be carried out considering the effects on the mid-ship section of an explosion occurring in the plane of the mid-ship section.

Other transverse sections are to be assessed if considered necessary by the Society (i.e. where a significant structural discontinuity exists in the longitudinal structural elements of the ship).

2.4.2 Identification of the iso-HSF curve

The iso-HSF curve is the curve outside which the whipping response of the ship is to be calculated, defined by the point in the fluid domain having the HSF (see Fig 3) defined by the Naval Authority.

Figure 3



2.4.3 Calculation grid

One "calculation grid" is to be defined for the angles and distances R_{SF} as given in Tab 1 and where:

α : is the angle measured with respect to the sea surface, of the line joining the centre of the charge and the intersection between the water line and the longitudinal plane of symmetry of the ship;

R_{SF} : is the distance between the centre of the charge and the intersection between the water line and the longitudinal plane of symmetry of the ship. It is defined as a percentage of the distance R that corresponds to the given H_{SF}, as shown in Fig 4.

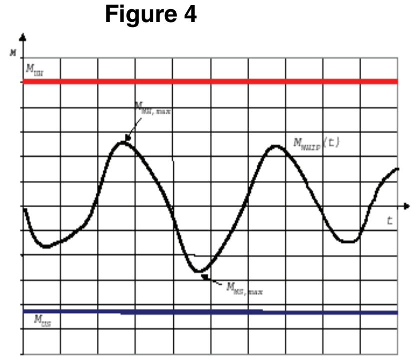
For any position of the charge corresponding to a couple of values α and $R_{SF,}$ the following is to be verified:

$R_{max} < R_{SF}$

Table 1

Angle α, [deg]	Distance R_{SF} [% of R]		
	100%	125%	150%
20	f1,1	f1,2	...
30	f2,1	...	
40	f3,1		
50			
60	...		
70	...	fi,j	
80			...
90		...	$f_{8,3}$

Figure 4



2.4.4 Frequency of the pulsating gas bubble

The frequency $f_{i,j}$ is to be calculated, in Hz, according to the following formula.

$$f_{i,j} = \frac{1}{t_1}$$

where t_1 is the duration of the first pulse of the gas bubble, as calculated in [2.2] for the mass of the charge W at a depth d defined as:

$$d = \frac{R_{SF}R}{100 \sin\alpha}$$

2.4.5 First natural frequency of the hull beam of the ship

The first natural frequency f_1 of the hull beam of the ship is to be calculated by means of:

- a one-dimensional beam model (generally 20-30 beam elements are enough to model the ship), or
- a 3D Finite Element model.

Alternative methods of analysis may be accepted by the Society on a case-by-case basis.

2.4.6 Critical positions of the charge

The critical positions of the charge, in order to determine possible resonance phenomena, are identified by those values of R_{SF} and α for which the corresponding frequencies $f_{i,j}$ are within the range:

$$0,9 f_1 \le f_{i,j} \le 1,1 f_1$$

2.4.7 Calculation of the dynamic response of the ship

For each critical position of the charge a dynamic calculation of the transient response of the ship is to be carried out in order to obtain the induced vertical bending moment M_{WHIP} as a function of time.

The procedure to evaluate the load acting on the structural model of the ship due to the gas bubble generated by an underwater explosion is to be based on the calculation of the hydrodynamics of the ship's hull, of the bubble and on evaluation of the fluid structural interaction.

The general criteria to set up the mathematical model, suitable to allow the application of the loads to a finite element model, are described in [2.5].

The structural model may be the same beam model already described in paragraph [2.4.5] above, being the virtual added mass calculated in way of the first natural frequency of the hull beam.

A linear transient dynamic analysis is to be carried out and the induced vertical bending moment M_{WHIP} vs. time is to be calculated, see Fig 4.

2.4.8 Hull girder ultimate bending capacity

The ultimate bending moment M_U of the hull is to be calculated, in hogging, M_{UH}, and sagging, M_{US}, conditions, as specified in Pt B, Ch 6, Sec 3.

2.4.9 Whipping factor WF

The Wipping Factor WF_H and WF_S are to be calculated for the hull transverse sections under consideration:

$$WF_H \leq \frac{M_{WH,\,max}}{M_{UH}}$$

$$WF_S \leq \frac{M_{WS,\,max}}{M_{US}}$$

Where $M_{WH,max}$ and $M_{WS,max}$ are the maximum value of the function M_{WHIP} for the hogging and sagging conditions, respectively, see Fig 4. The whipping factor WF is the maximum between WF_H and WF_S.

2.4.10 Acceptance criteria

The WF evaluated according to [2.4.9] is to satisfy the following:

$$WF \leq \frac{1}{\gamma_R}$$

Where γ_R is the partial safety factor to be assumed equal to 1.1.

2.5 Procedure to evaluate the load acting on the structural model of the ship

2.5.1 Mathematical model

In order to simplify the procedure, the mathematical model is divided into three sub-models, in addition to the structural one already defined in the above:

- hull hydrodynamics, see [2.5.2],
- gas bubble hydrodynamics, see [2.5.3],
- interaction hydrodynamics, see [2.5.4].

2.5.2 Hull hydrodynamics

The effect on the hull of the inertia of surrounding water can be dealt by means of the standard strip theory.

At any lumped mass, the added mass is assumed depending on the Lewis coefficient, which allow the shape of the ship to be taken into account.

As the whipping phenomenon generally involves the vibration of the ship according to her first modes, the above coefficient is to be chosen, with minor errors, according to the 2-node mode.

On the basis of the above hypothesis, the forces acting on the ship due only to the pressure of the surrounding water are to be evaluated taking into account the contribution of the added mass and the hydrostatic buoyancy force.

2.5.3 Gas bubble hydrodynamics

The hypotheses for the hydrodynamics of the gas bubble are:

- the fluid is incompressible and inviscid;
- the bubble shape is to be assumed to maintain its spherical shape during the development of its motion;
- the gas bubble motion is calculated in free-field (the presence of the ship does not influence the bubble motions);

Where deemed necessary by the Society the following effects are to be taken into consideration.

- the migration of the gas bubble toward the sea surface;
- the dissipation terms.

On the basis of the above hypothesis, the differential equations of motion of the gas bubble, which can be found in literature, are written assuming a velocity potential. They are solved evaluating the value of the bubble radius vs. time and, consequently, its first and second derivative, that is the acceleration field associated with the gas bubble.

The boundary condition to solve the relevant differential equations is the initial radius of the bubble, to be assumed as the diameter of the charge.

2.5.4 Interaction hydrodynamics

The interaction model is based on the same hypothesis (incompressible and inviscid) as the bubble model.

The most important physical approximation which allow to evaluate the forces exerted on the ship by the bubble, consistent with the standard strip theory, is that the bubble produces purely radial flow.

The velocities / accelerations produced by this flow define the flow field which interact with the ship.

The fluid force acting on each section of the ship, to be assigned to each lumped mass, is to be divided into two components:

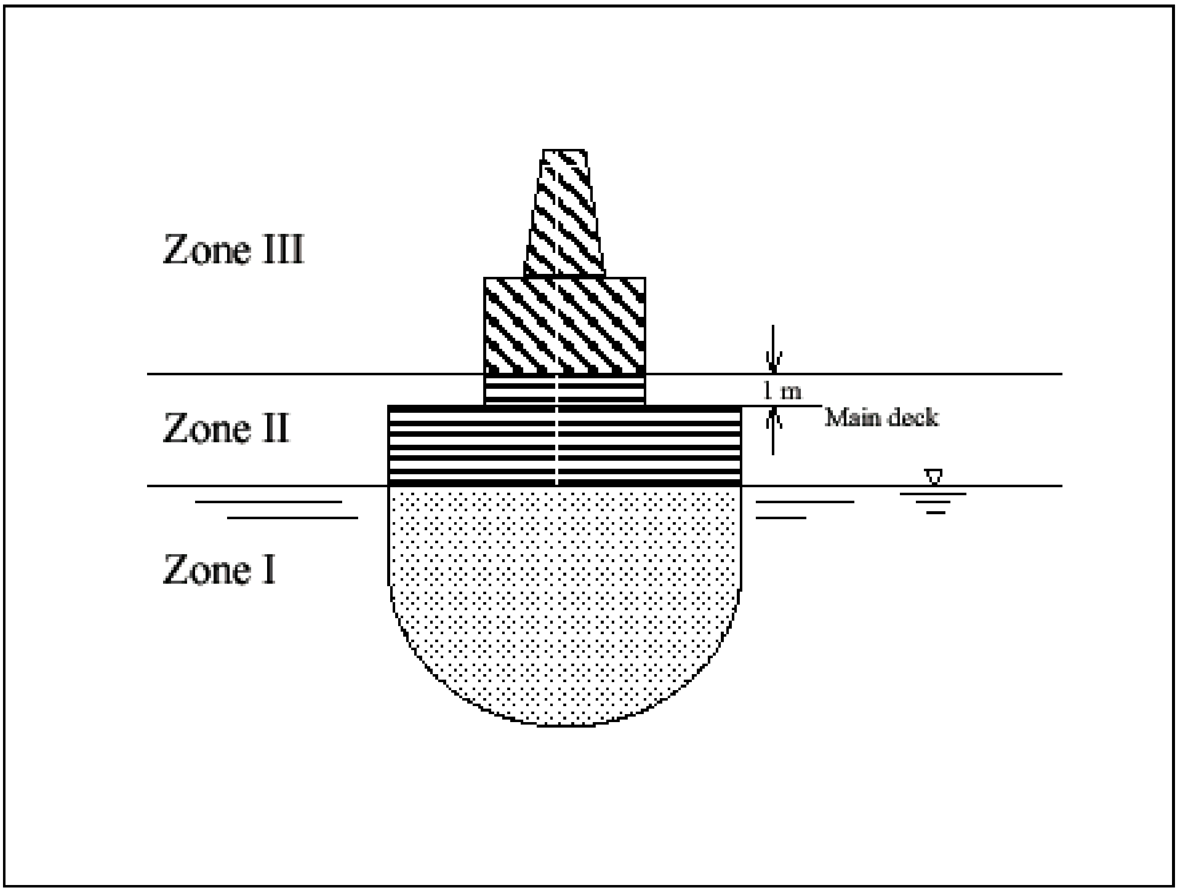
- the first one is proportional to the strip theory added mass and to the relative acceleration between the water and the ship;
- the second one is the uniform pressure gradient produced by the gas bubble which induces a buoyancy force proportional to the displaced volume of water.

2.6 Criteria for the asssessment of the notation SHOCK-FUNCT

2.6.1 Shock zones

The interaction model is based on the same hypothesis (incompressible and inviscid) as the bubble model.

Figure 5 : Subdivision of the ship in shock zones



2.6.2 Shock class of the components included in the "Shock Catalog"

To each component included in the "Shock Catalog", a shock class is assigned, as a function of the HSF the ship is designed to withstand and the Zone in which it is located. In this respect, it is noted that once the hull shock factor, HSF, the charge mass, W, and the Zone(s) are identified (by the Naval Authority) the Shock class, the acceleration a_o and the type of test are automatically defined. However, these are confidential information, which are normally known only by the Naval Authority and the Designer, and are not communicated to the Society.

Depending on the shock class assigned to a component, the following parameters are defined:

- acceleration "a_o " which depends on the mass and the first natural frequency of the system composed by the component and the mounting;
- characteristics of the test load to be used by the "Shock testing machine" or definition of the test geometry if a shock test with the component on a barge is carried out.

2.6.3 Structural assessment of mountings

The structural assessment of the mounting of each component - to be tested according to [2.6.4] - is to be carried out by means of a simplified dynamic analysis to be performed applying in a quasi-static way the acceleration "a_o" pertaining to the component mounted on it.

The acceleration is to be applied in the three directions vertical z, transverse y and longitudinal x according to the coordinate system defined in Pt B, Ch 1, Sec 1, as:

- $az=a_o$: in the vertical direction;
- $ay=0,5a_o$: in the tranverse direction;
- $az=0,25a_o$: in the longitudinal direction;

Three single simplified dynamic analyses are to be carried out, each one considering only one acceleration component.

2.6.4 Assessment of the components included in the "Shock Catalog" that can be tested

Components are to be of a type tested on an approved "Shock testing machine". If their mass is higher than the maximum mass testable they must be tested, on a barge subject to an underwater non contact explosion.

Load test of the "Shock testing machine" and explosion geometry for the shock test are defined on the basis of the Shock class of the component to be tested.

2.6.5 Assessment of the components included in the " Shock Catalog" that cannot be tested

This assessment is to be carried out for:

- shaft lines;
- reduction gears;
- main engines foundations;
- diesel generators foundations.

Other components are to be tested when deemed necessary by the Society.

A direct calculation, to be carried out by dynamic analysis, is to be performed by loading the structural model using the acceleration, velocity or displacement time histories supplied by the Naval Authority, defined as a function of the shock class.

For the shaft lines and in general for components extending significantly in the longitudinal direction it is necessary to carry out a calculation taking into account the presence of the hull, modelling a significant portion of the same and applying the pressure load time history defined in [2.1.1].

The extension of the model and the type of the mesh are to be such that the interactions of the hull with the shaft lines are correctly modelled.

2.6.6 Assessment of external hull appendages such as rudder, fins, propellers, sonar etc.

External submerged hull appendages are to be calculated by a dynamic analysis applying the pressure load history defined [2.1.1].

2.6.7 Acceptance criteria

a) Mountings, see [2.6.3]

   The checking criteria on stresses in Pt B, Ch 7, Sec 3, [4.3] are to be complied with.

b) Components included in the "Shock Catalog" that can be tested, see [2.6.4]

c) Components included in the "Shock Catalog" that cannot be tested, see [2.6.5]

   For all the components and structures calculated the checking criteria on stresses in Pt B, Ch 7, Sec 3, [4.3] are to be complied with.

   For the shaft line, including the supporting structures, or for components significantly extending along the longitudinal axis of the ship, if any, in addition to the above criteria, the elastic deformations are to be such not to impair the functioning of the component.

d) External hull appendages, see [2.6.6]

   For all the appendages and their supporting structures, the checking criteria on stresses in Pt B, Ch 7, Sec 3, [4.3] are to be complied with.

2.7 Machinery and systems installation on board for SHOCK-FUNCT

2.7.1 General

In continuously manned spaces, all machinery, equipments and heavy materials in general are to be secured in a proper manner in order to avoid injury to personnel; ad-hoc calculation for mounting of machinery and equipment not included in the Shock catalog may be required by the Society on a case by case basis when it is considered that the damage of the machinery/equipment may cause injury to personnel or indirect damage on other systems that are essential for the maintenance of the required performance level.

2.7.2 Machinery and systems essential for the performance level

For all machinery and equipments that are essential for the maintenance of the required performance level it is to be verified that:

- are installed on resilient mounting in accordance with the Shock catalog, or
- have been tested for shock resistance in accordance with the indication of the Naval Authority and under witnessing of a recognised third party, or
- a direct calculation in accordance with [2.6.5] has been carried out.

2.7.3 Machinery installed on resilient mounting

For machinery and equipment installed on resilient mounting is to be verified that:

- the machinery has enough clearance in respect of surrounding fixed parts and structures in order to allow the maximum expected displacement in case of shock.
- connections to fixed piping systems are to be provided by means of flexible hoses or expansion joints specifically tested, in accordance with the requirements of the Naval Authority, to withstand the expected deformation.
- electrical cables are to be installed with enough slack to allow the expected displacement of the machinery under shock.

2.7.4 Fixed systems

Fixed parts of systems (such as piping, valves, ventilation ducts, etc) that are essential for the maintenance of the required performance level are to be suitably stiffened.

Shipyard is to provide typical arrangement of the stiffening of piping and ducts covering all required sizes and materials.

SECTION 7 TERRORIST ATTACK - "TERR"

1 General

1.1 Scope

1.1.1 The additional class notation **TERR** is assigned to a ship in order to certify that some structures have ballistic protection capable of protecting certain areas from small arm gun shots.

1.2 Field of application

1.2.1 The additional class notation **TERR** is assigned to ships complying with the requirements of this Section.

The number of protected areas **n** completes the above notation in accordance with Pt A, Ch 1, Sec 2, [7.3.8].

1.3 Condition for the assignment

1.3.1 The assignment of the notation implies that an analysis has been carried out for the plating of sides, bulkheads and decks surrounding the protected areas and that such plating comply with the requirements of this Section.

Details of the calculation method and the structural performance achieved, based on the specified loads, will not be published and will be only disclosed to the Naval Authority.

1.4 Documentation to be submitted

1.4.1 Documentation to be submitted for approval

When a non-structural ballistic protection is fitted, the relevant plan is to be submitted for approval, in addition to the plans and documents listed in Pt B, Ch 1, Sec 3.

1.4.2 Documentation to be submitted for information

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

- the identification of the "protected areas";
- the characteristics of the small arms considered (caliber, projectiles type, distance, initial velocity).

These confidential input data considered for the assignment of the notation are included in the confidential annexes of the class certificate.

In addition, a report on the structural analyses carried out is to be submitted for information, which is to include:

- the description of the calculation procedure
- the assumptions made
- the summary of the results obtained.

1.5 Assignment of the notation

1.5.1 If requested by the Naval Authority or by the Shipyard, the **TERR** notation is assigned by the Society if the acceptance criteria specified in this section are fulfilled.

1.5.2 The analyses are to be carried out and the relevant documentation are to be submitted to the Society well in advance to the final design of the structures so as not to interfere with the class related structural plan approval.

1.6 Definitions

1.6.1 Protected area

A protected area is an area such that components or personnel located inside this area are protected and are able to maintain their functionality after an external small arms terrorist attach

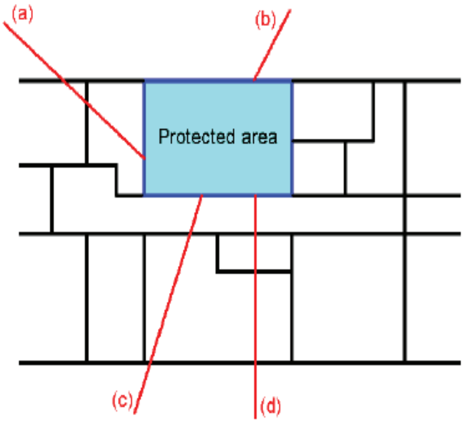
2 Analysis

2.1 Assessment

2.1.1 The following procedure is to be applied to evaluate the capability of the ship structures to avoid the penetration of projectiles inside the protected areas, assuming that the terrorist attack comes from outside:

- for each protected area, defining the possible trajectories that can be followed by a projectile coming from outside the ship, as shown in Fig 1, where (a) to (d) are four possible trajectories, indicated by way of example;
- identifying the ship structures that surround each protected area and are potentially crossed by the projectile trajectories;
- for each trajectory, evaluating the projectiles penetrations through the above mentioned structures, which surround the protected area;
- for each structure, assessing the residual velocity after penetration.

Figure 1 : Protected area and projectile trajectories



The ballistic characteristics of each structure, that is their capability not to be penetrated by a projectile of assigned characteristics, are to be evaluated by means of experimental test.

In case experimental data are not available, at a preliminary design stage the formulae in Sec 4, [2.2] and Sec 4, [2.3] may be used to calculate the residual velocity and mass of the projectile after the penetration of a certain structure.

2.2 Acceptance criteria

2.2.1 The projectile is not to penetrate in the protected area.

This means that the projectile residual velocity after penetration of all the structures, crossed by any trajectory, before the boundary of the protected area is to be lower than the minimum velocity needed to penetrate this boundary.

SECTION 8 SEA-KEEPING ASSESSMENT - "SEA-KEEP"

1 General

1.1 Introduction

1.1.1 Sea-keeping notations

The confidential additional class notations **SEA-KEEP-FLY**, **SEA-KEEP-RAS** and **SEA-KEEP-WEAP** are assigned to ships whose specific sea-keeping performance levels are assured up to a certain limiting sea state.

The above notations are assigned according to the specified performance assured:

- -**FLY-X(L,M,H)**, for flight operations
- -**RAS-X(L,M,H)**, replenishment at sea
- -**WEAP-X(L,M,H)**, for weapons systems operations.

where **X** specifies the sea state number, followed by a letter indicating whether it is **H**igh, **M**id or **L**ow sea state, up to which the required sea-keeping performance is maintained. E.g. the additional notation **SEA-KEEP-FLY-3(H)** is assigned to a ship that can satisfy the flight operation limits up to high sea state 3.

1.1.2 Operation limits

The operation limits depend on the specific operation the vessel must perform. For flight, replenishment at sea and weapons systems operations the limits ensure that:

- The aircraft/helicopters can be launched and recovered.
- The replenishment at sea operations can be carried out safely and effectively.
- The weapons systems can be operated and handled safely and effectively.

Operational limits for flight, replenishment at sea and weapons systems operations are taken according to the NATO standards STANAG 4154 Ed.3.

1.1.3 Verification approach

The additional notations **SEA-KEEP-FLY-X(L,M,H)**, **SEA-KEEP-RAS-X(L,M,H)** and **SEA-KEEP-WEAP-X(L,M,H)** are assigned to ships whenever the limiting sea state **X** for the specific operation has been determined by the use of sea-keeping computer calculations according to the indications in Pt B, Ch 3, App 6.

1.1.4 Flight operations (FLY)

In terms of sea-keeping effects on performance, **FLY** involves a special and fairly consistent set of systems, tasks and criteria that must always be considered:

- Aircraft take-off and landing
- Helicopter and STOVL (Short Take-Off Vertical Landing) take-off and landing
- Near-ship operations (e.g. helicopter in-flight refuelling (HIFR))
- On-deck handling (e.g. fuelling, folding wings or rotors, transit into hangar).

1.1.5 Replenishment at sea (RAS)

Replenishment at sea represents a wide variety of resupply activities, including:

- Connected replenishment (CONREP)
- Fuelling 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)

Weapons systems operations 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.

1.2 Assessment procedure

1.2.1 Parameters

The parameters to be considered for the assessment of the sea-keeping are defined in [2] , [3] and [4].

1.2.2 Evaluation

The values of the ship sea-keeping parameters are to be assessed by means of computer calculations. Small-scale model tests in a model basin are to be used to validate the calculations.

The computer calculations have to be performed as described in Pt B, Ch 3, App 6, and the following documentation must be provided:

- Justification of the validity of the used software
- Parameters to be calculated
- Computation input data
- Computation results
- Model test results that verifies calculated results.

Concerning model tests the following documentation must 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 categorise wave conditions and normally a sea state comprises a significant wave height Hs and a wave period.

The environmental conditions are to be described by specifying a sea state according to Tab 1.

Whenever computer calculations or model scale tests are used, i.e. when the environmental conditions are selectable, the sea states used for the verification of the criteria in [2.2] and [3.3] should be defined as described in [1.3.2] and [1.3.3].

Table 1 : Sea states

Sea state	Significant wave height range, in m	Zero up-crossing wave period range, in sec
0-1	0-01	-
2	0,1-0,5	2,0-9,0
3	0,5-1,25	2,5-10,5
4	1,25-2,5	3,0-11,5
5	2,5-4,0	3,5-12,0
6	4,0-6,0	4,0-12,5
7	6,0-9,0	5,0-13,0
8	9,0-14,0	6,0-13,5
>8	>14,0	>13,0

1.3.2 Wave height

Generally, the references to the 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 shown in Tab 1 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.

A 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 should be the largest significant wave height relative to the specified sea state; if a mid sea state 6 is specified, Hs should be taken as 5 m, if only sea state 6 is specified, Hs should be taken equal to 6 m.

1.3.3 Wave period

Generally, references to the wave period are to be taken as the zero up-crossing wave period T_Z, i.e. the average time interval between upward crossings of the mean value.

The description of sea states in Tab 1 defines the limits $T_{Z,MIN}$ and $T_{Z,MAX}$ of the wave period.

As a minimum requirement, the verifications should be carried out for at least four different wave periods. The wave periods to be considered are defined based on the ship length L. However, they are not to be taken outside the range of wave periods for the considered sea state, defined in [2.2].

-$T_{Z1}=T_{Z,MIN}$, according to Tab 1.

$$-T_{Z2} = 0,68\sqrt{L}$$

$$-T_{Z3} = 0,8\sqrt{L}$$

$$-T_{Z4} = 0,92\sqrt{L}$$

2 Flight operations (FLY)

2.1 General

2.1.1 Scope

The scope of verifying the sea-keeping performance is to determine in what sea state the ship motions and accelerations become so severe that they prevent or obstruct the flight operations.

2.1.2 Requirements

The requirements for verifying that the crew is able to carry out their tasks in flight operations is that the parameters evaluated do not exceed the criteria defined in [2.2] in a range of heading not lower than 120° with the ship sailing at cruise speed (or at a different speed if required for flight operations as indicated by the Naval Authority).

The limiting sea state for flight operations is thus defined as the most severe sea state where flight operations can be carried out safely and effectively. The limiting sea state number(s) for each operation connected with the flight operation, defined according to Tab 1, is to be detailed in the confidential annex to the Class Certificate.

2.2 Criteria

2.2.1 Fixed wing aircraft launch & recovery

Limits for Conventional Take-Off and Landing (CTOL) of fixed wing aircraft from aircraft carriers are listed in Tab 2, as RMS values of roll, pitch, vertical and lateral displacement and vertical velocity.

Table 2 : Fixed wing aircraft - launch & recovery criteria limits

Governing factors	Performance limitations		
	Motion	Limit	Location
Aircraft handling	Roll	See rool criteria, Fig 1	
Sink off bow and OLS limits	Pitch	See pitch criteria, Fig 2	
Ramp clearance	Vertical displace-ment	0,8 m	Stern ramp at flight deck
Landing line-up	Lateral dis-placement	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

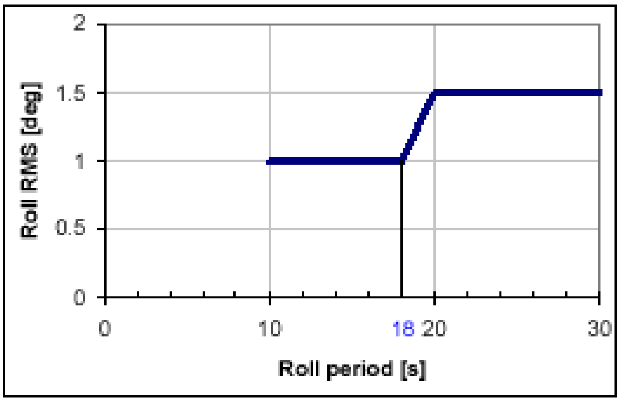
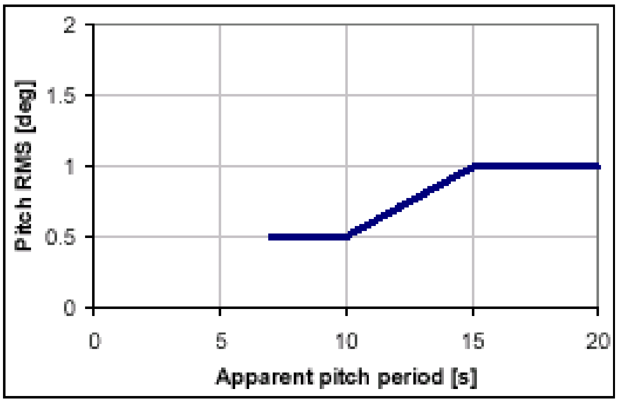


Figure 2 : Pitch limits



2.2.2 Fixed wing aircraft handling

Limits on support equipment for aircraft handling are given in Tab 3 as RMS values for pitch and roll motion. Support operations encompass a wide range of functions (e.g. ord-nance handling, aircraft arming, fuelling, engine changing), hence the limits for support equipment are presented for the most restrictive of these.

Table 3 : Fixed wing aircraft - handling criteria limits

Subsystem	Performance limitations		
	Motion	Limit	Location
Aircraft and handling equipment	Roll	See rool criteria, Fig 1	
	Pitch	See pitch criteria, Fig 2	
Elevators	Wetness	5/hr	Bottom inner leading elevator edge

2.2.3 Helicopter and STOVL launch & recovery

Limits for vertical and short takeoff and vertical landing (VTOL and STOVL) are given in Tab 4 as RMS values of roll and pitch motion and vertical velocity.

Table 4 : Helicopter and STOVL - Launch & recovery criteria limits

Operation	Performance limitations		
	Motion	Limit	Location
Generic helicopter launch	Roll	2,5°	
	Pitch	1,5°	
Generic short takeoff	Roll	2,5°	
	Pitch	1,5°	
Generic helicopter recovery	Roll	2,5°	
	Pitch	1,5°	
	Vertical velocity	1,0 m/s	Landing spot
Note 1: All limits are given in terms of RMS amplitude			

2.2.4 Helicopter and STOVL handling

Limits for handling of helicopter and STOVL are given in Tab 5 as RMS values of roll and pitch motion.

Table 5 : Helicopter and STOVL - 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 scope of verifying the sea-keeping performance is to determine in what sea state the ship motions and accelera-tions become so severe that they prevent or obstruct the replenishment at sea operations.

3.1.2 Requirements

The requirements for certifying that the crew is able to carry out their tasks in RAS operations is that the parameters evaluated do not exceed the criteria defined in [3.3]

The limiting sea state for replenishment at sea operations is thus defined as the most severe sea state where the operations can be carried out safely and effectively. The limiting sea state number(s) for each operation connected with the RAS operation, defined according to Tab 1, is to be detailed in the confidential annex to the Class Certificate.

3.2 Parameters

3.2.1 Motion Sickness Incidence (MSI)

The motion sickness incidence (MSI) is described in Pt B, Ch 3, Sec 4.

3.2.2 Motion Induced Interruption (MII)

The motion induced interruption (MII) is described in Pt B, Ch 3, Sec 4.

3.3 Criteria

3.3.1 Connected replenishment (CONREP)

Limits for connected replenishment (CONREP) between two ships are listed in Tab 6 as RMS values of roll and pitch motion, and as human factor limits expressed in MSI and MII.

Table 6 : Connected replenishment 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
	MSI	20% of crew, 4 hr	CONREP station
	Wetness index	0,5/hr	CONREP station
Note 1: Roll and pitch limits are given in terms of RMS amplitude			

3.3.2 Fuelling at sea (FAS)

Limits for (flexible connected) fuelling at sea (FAS) between two ships are listed in Tab 7 as human factor limits expressed in MSI, MII and wetness index.

Table 7 : Fuelling at sea criteria limits

Limiting factor	Performance Limitations		
	Motion	Limit	Location
Personnel	MII	0,5/min	FAS station
	MSI	20% of crew, 4 hr	FAS station
	Wetness index	0,5/hr	FAS station
Note 1: All limits are given in terms of RMS amplitude			

3.3.3 Vertical replenishment (VERTREP)

Limits for vertical replenishment from helicopters (VERTREP) are listed in Tab 8 as RMS values of roll and pitch motion, vertical displacement and vertical velocity together with human factor limits expressed in MSI and MII.

Table 8 : Vertical replenishment 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
	MSI	20% of crew, 4 hr	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 scope of verifying the functionality of the on-board weapons systems is to ensure that the ship motions and accelerations, in weather conditions where the ship is expected to carry out her mission, do not become so severe that the weapons systems lose functionality.

4.1.2 Requirements

The requirement for verifying that the weapons systems are operable is that the parameters evaluated do not exceed the criteria defined in [4.2] with the ship sailing at maximum speed (or at a different speed if required for weapon operations as indicated by the Naval Authority) and without restriction in heading, unless for Missile Systems (see [4.2.4]) where it is accepted that the criteria are complied with for a range of heading not lower than 120°.

The limiting sea state for weapons systems operations is thus defined as the most severe sea state where the operations can be carried out safely and effectively. The limiting sea state number(s) for each operation connected with the weapon operation, defined according to [4.2.4], is to be detailed in the confidential annex to the Class Certificate.

4.2 Criteria

4.2.1 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.

4.2.2 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 9.

Table 9 : 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			

4.2.3 Guns

Criteria limits are given in order to avoid the motion effects degradation in single hit probabilities of a 5"/54 gun with MK 68 Fire Control system. The same limits for roll and pitch apply for a 76/62 Oto Melara gun system.

Table 10 : Gun criteria limits

Representive gun system	Performance Limitations		
	Motion	Limit	Location
5"/54	Roll	3,8°	
	Pitch	3,8°	
	Vertical velocity	0,5m/sec	Gun barrel tip
Note 1: Limits are given in terms of RMS amplitude			

4.2.4 Missile systems

Maximum design limits for both trainable and vertical launch systems are given in the following.

It must be noted that these 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.

Table 11 : Trainable missile systems 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		

The roll pitch and yaw limits listed in Tab 12 for vertical launch system operations are associated with minimum periods of 9,9 and 6 seconds, respectively. The limiting values will decrease below the minimum periods.

Table 12 : Vertical launch systems 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
Note 1: Limits are given in terms of RMS amplitude			

4.2.5 Torpedo systems

The criteria limits for torpedo system operation are defined below. 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 13 : Torpedo systems 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		

4.2.6 Support equipment

Support operations encompass a wide range of functions (e.g. ordnance handling, aming maintenance), hence the limits to support equipment are defined for the most restrictive of these.

Table 14 : Support equipment criteria limits

Performance Limitations		
Motion	Limit	Location
Roll	1,8°	
Pitch	1,8°	
Motion Induced Interruption (MII)	1/min	Task location
Note 1: Roll and pitch limits are given in terms of RMS amplitude		

SECTION 9 NBC-PROT

1 General Requirements

1.1 General

1.1.1 Application

The **NBC-PROT**, in accordance with Pt A, Ch 1, Sec 2, [7.3.10] , is assigned to naval ships provided with arrangements and systems complying with the requirements of this Section.

The purpose of nuclear biological chemical (**NBC**) protection (**PROT**) is to maintain the ship operation in areas contaminated by **NBC** products.

The ship may be provided with a citadel, subdivided or not in sub-citadels, or a sanctuary protection.

1.2 Definitions

1.2.1 Citadel

A citadel is the gastight envelope of hull and superstructure whose enclosed spaces are provided with independent systems assuring a toxic free area, free from any **NBC** hazard by means of suitable overpressure compared to atmosphere pressure.

The citadel could be divided in sub-citadels which, as far as practicable, coincide with safety zones of the ship. The sub-citadels consist of a group of interconnecting compartments enclosed by a gastight boundary with the independent systems necessary to provide a toxic free area, free from any NBC hazard as the citadel not subdivided.

1.2.2 Sanctuary

A sanctuary is an integral or temporary group of rooms on ships which are not provided with a citadel. The sanctuary is provided with airlock, cleansing station and **NBC** filter station similar to that of a citadel. A sanctuary may be formed by a mobile equipment maintained in over-pressure in relation to atmosphere pressure.

1.2.3 Cleansing station

A cleansing station is a group of rooms suitably arranged and equipped whereby **NBC** decontamination of personnel and materials can take place and where suitable arrangements are provided for containment of contaminated equipment.

1.2.4 Airlock

An airlock is a compartment with two doors between the toxic free area and cleansing station or the source of the **NBC** hazard.

Airlocks are to be normally purged with clean air to allow personnel to pass from one area to another area without contaminants entering the toxic free area.

1.2.5 Individual protective equipment (IPE)

Individual protective equipment is the personal clothing and equipment required to protect an individual from **NBC** hazard.

It normally consists of **NBC** protective Suit, Gloves, protective, **NBC** (inner and outer), Over-boots, **NBC** (worn over seagoing working boots) and **NBC** mask, which is to be in addition or in alternative to the components of equipment required by the Naval Authority for **NBC** teams.

As far as practicable outside the citadel and the sanctuary, all accesses for operation and maintenance of equipment should be designed for personnel wearing the IPE.

1.2.6 HEPA Filter

HEPA filter means an High Efficiency Particulate filter.

1.2.7 NBC Filter station

The **NBC** filter station is the room where the apparatus of decontamination of the external fresh air to be delivered to citadel, sub-citadel,or fixed sanctuary, cleansings or airlocks, or parts thereof are positioned.

1.2.8 Detectors

Detectors are the sensitive devices located outside or inside the citadel, capable of detecting hazard **NBC** products.

Devices approved by the Naval Authority on the basis of classified naval standards are considered approved by the Society.

1.3 Documentation

1.3.1 Plans

The plans listed in Tab 1 are to be submitted for information or approval of the Society as appropriate

The plans are to be schematic and functional and they shall contain, or operation manuals or specification are to be provided, all information necessary for their correct interpretation and verification.

Table 1

N°	A/I **(1)**	Documentation
1	I	General arrangement plan of the ship
2	A	Plans of the citadel layout and if any of its sub-citadels, or sanctuary, cleansing stations, airlocks , NBC filter stations, doors, openings, hatches, command and control centres
3	A	Plans of interior spaces supplied with non contaminated air either directly or indirectly, machinery spaces which are to be in use and other interior spaces which are to be in use during NBC protection stage
4	A	Plans of the NBC protection installations describing system safety approach and function design
5	A	Plans of the NBC protection installations describing instrumentation, control and safety systems, including their particulars
6	I	Plans of testing procedure of the NBC protection installation specifying if they are classified in total or in part
(1) A: to be submitted for approval in four copies I: to be submitted for information		

1.4 Design

1.4.1 Lay-out arrangements

The ship **NBC** protection is to be considered at the very early stage in the ship design.

The lay-out arrangements of ship **NBC** protection is to be agreed by consultation with Naval Authority, Designer and Society.

Each design stage of lay-out arrangement of ship **NBC** Protection is to be analysed with risk analysis for the purpose to single out if by providing that designed ship **NBC** protection the remaining hazards are consistent with the ship **NBC** protection objectives foreseen by Naval Authority for operation and mission of that ship. Such remaining hazard are to be evaluated with a hazard evaluation technique such as What-If Analysis.

Accounting the Naval Authority objectives, the hazard analysis has to highlight the necessary measures to be provided for structural boundaries, apparatuses for propulsion and essential services, systems, and arrangements and equipments, to copy with the **NBC** threat to be directed to minimize the interior spaces contamination and to facilitate the subsequent decontamination.

1.4.2 Ship spaces

The ship spaces to be covered by **NBC** ship protection are to be indicated by Naval Authority on the basis of **NBC** protection objectives foreseen for the ship mission and operation.

If he ship has to operate without limitation the citadel, in general should include all inside ship spaces. In any case the citadel has to include all control stations, all accommodation spaces, galleys, victuals spaces, and manned machinery spaces. Particular attention is to be given to providing the maximum shielding for victual spaces as well as control stations. Furthermore the inclusion in the citadel of unmanned machinery spaces, storages, stores and workshops should be considered accounting the ship operation and mission. However some inside ship spaces could be excluded from the citadel totally such as paint storage or partially included such as hangars for aircrafts an/or helicopters and re-fuelling air craft/helicopter stations. The Naval Authority may determine that hangars as well as vehicle spaces, ro-ro vehicle spaces are to be **NBC** protected. In such cases the hangars and such spaces are to be considered independent from the citadel.

When the Naval Authority has determined that in the case of partial damage of citadel boundaries the **NBC** ship protection has not to limit the ship mission and operation, the citadel is to be divided in zones that is in sub-citadels . Each sub-citadel is to be considered as the citadel in respect of **NBC** protection measures and possibly has to have the same boundaries which boundary one or more safety zones. The pressurization of machinery space may be obtained by discharging pressurized uncontaminated air from zones of the citadel.

In the case the Naval Authority has determined that zones are to be provided in sub-citadels the relevant accesses are to be provided trough airlocks.

The exterior surfaces of citadel as far as practicable and reasonable are to be plain, smooth, and without projection and/or discountenance.

Materials for superficial treatment as far as practicable and reasonable are to be easy to be decontaminated from **NBC** agents.

1.4.3 Systems

The design and the installation of the systems are to be such that they withstand shocks and vibrations. Pipes and water spray nozzles shall be of not corrosion type in marine environment.

The citadel and sub-citadel of **NBC** protection are to be provided with appropriated exhaust having non return valves venting to airlocks, cleansing stations, machinery spaces, or to the open, or in any other space suitable to the Naval Authority.

Non return valves are to be provided on the main duct of decontaminated air so that in any case venting to the opening through such duct is not possible.

Monitoring and control of **NBC** systems and arrangements shall be from control damage central station. Such monitoring and control shall include also the starting of decontaminated air fans and the measuring of differential pressure between inlet and outlet of air in fan duct.

The fans of decontaminated air should be installed down stream of the **NBC** filters.

Each sub-citadel, see [1.4.2], shall be provided with its own dedicated system of decontaminated air.

The relative humidity of air and the temperature of air up stream of activated carbon filters shall be as required by the filter manufacturer. The air passing through such filters shall be so dry that in every environmental condition condensate is not generated in the filters.

1.4.4 Duct and pipe discharges

The ducts and pipes discharging to open shall be provided with water seal against entrance of air from the opening which shall have sizes not greater than the duct or the pipe and shall be capable of preserving the water seal even in heavy sea. The height of water seal of piping discharging over board in position above the minimum side draft relevant to ships motions shall be adequate for inside over-pressure.

The discharge of airflow pipes are to be positioned clear of air inlet , access and doors.

Pressure containers shall have their safety devices (rupture disk or safety valves) discharging to outside of the citadel. In the case the discharging pipe is relevant to a rupture disk, the pipe is to be provided with a non return valve.

1.5 Citadel or sanctuary provision

1.5.1 The ship shall be provided with a citadel or a sanctuary for **NBC** protection as the Naval Authority may consider necessary.

1.6 Manual and instruction

1.6.1 There shall be on board of the ship manual and instruction for the action to be taken in case of **NBC** detection and for the operation and use of all provisions on board dealing with **NBC** protection.

2 Arrangements

2.1 Citadel and sanctuary boundary

2.1.1 The citadel and sanctuary outer boundary is to be gastigh.

2.1.2 The citadel or sanctuary ventilation inlets , outlets and other openings which are not exclusive air supply duct directly to engines, shall be able to be gastight closed, by automatic hand operation, from inside the citadel or sanctuary. Where the ship is provided with a central damage control station there shall also be possible to operate such closing from the station.

2.1.3 Doors , airlocks and hatches leading into citadel or sanctuary shall be of construction ensuring a quick closing and gastight integrity. The closed and open position of doors and hatches are to be signalled in the central damage control station.

2.1.4 At least one airlock for access to weather deck by personnel wearing IPE should be provide in each safety zone in the citadel.

2.1.5 There shall be at least one cleansing station for every sub-citadel. Sanctuary shall be provided with at least one cleansing station.

2.1.6 Where the citadel is subdivided for **NBC** defence, the sub-citadels shall be autonomic in respect of accesses to weather deck, airlocks, cleansing stations and decontamination air.

Airlocks between **NBC** zones-sub-citadel of the citadel shall be arranged for purging in both directions.

2.1.7 The access to citadel, or sub-citadel, or to sanctuary from weather decks shall be through cleansing stations.

2.1.8 Each airlock, not connected to a cleansing station and which gives access to weather deck, during the **NBC** stage shall have the outer door provided with means for its lock which prevent the enter from weather decks and allow the exit to personnel wearing the IPE.

The same requirement applies to the airlocks in item [2.1.6] which is to be put in operation in the emergency case.

2.2 Airlocks

2.2.1 Airlocks in general shall comply with the following requirements:

a) Airlocks shall be enclosed by gastight divisions with gas tight doors spaced at least one meter apart.

b) Airlocks shall have a simple geometric form.They shall provide free and easy one way passage and shall have a deck area not less than 1,0 m. Airlocks are not to be used for other purpose, for instance as store rooms

c) Facilities shall be provided to prevent simultaneous opening of doors while the citadel, sub-citadel or sanctuary is in use.

d) The airlock spaces is to be mechanically ventilated with air purging from the better to the less protected or unprotected space.

2.3 Cleansing stations

2.3.1 The cleansing stations shall be retained the only way of entry for contaminated personnel into the citadel, or into sub-citadel, or in the sanctuary.

2.3.2 The cleansing station of the citadel, or of the sub-citadel, or of the sanctuary shall be sized, and the airlock shall be sized too, for the entry and transport of stretcher with casualty .

2.3.3 The cleansing stations in general shall comply with the following requirements:

a) The cleansing station, and its airlock, shall be enclosed by gastight divisions and gastight doors.

b) The cleansing station, and its airlock, shall have a simple geometric form providing for a free and easy one way passage.

c) Facilities shall be provided to prevent simultaneous opening of more than one gastight door of the cleansing station, including its airlock doors while the citadel, or sub-citadel, or the sanctuary are in use.

d) The cleansing station, and its airlock, shall be mechanically ventilated with air purging from the higher differential pressure to the lower, e.g. citadel-cleansing station-airlock-weather deck.

2.3.4 The cleansing station shall in general be so arranged as to allow:

a) outside the cleansing station airlock:
   1) initial decontamination by sea water shower located immediately outside the airlock entry door from the weather deck;

b) inside the cleansing station:
   1) complete undressing and storage of undressing;
   2) decontamination of personnel;
   3) cycle decontamination controls;
   4) dressing;
   5) continuous sight trough windows of undressing and decontamination areas;
   6) continuous purging of cleansing station and its airlock by stepped overpressure air from the citadel or sub-citadel, or sanctuary;
   7) drainage of washing water and showering water led overboard.

2.4 Propulsion machinery spaces, auxiliary machinery spaces and auxiliary systems - Arrangements for operation in NBC stage

2.4.1 All combustion machineries that are required to operate in closed down **NBC** condition shall have their fresh air intake ducted direct to and from outside atmosphere .Where the combustion machineries are enclosed in box their fresh air intake may be from inside the relevant box and the box shall have the fresh air intake ducted direct to and from outside atmosphere.

In any case the differential pressure in the box shall be lower than that in the machinery space environment.

2.4.2 Except as permitted in [2.4.1] the requirements in [2.1.2] are to be complied with. Such requirements are to be comply with also for ventilation openings of combustion machineries which are not in operation in the **NBC** stage.

2.4.3 Means shall be provided to control the temperature in machinery spaces and in the enclosed areas thereof, under **NBC** closed down conditions. Such temperature shall be suitable for manned spaces.

2.4.4 The machinery spaces shall be provided with air from citadel through appropriate designed non return valves.

2.4.5 The air shall be exhausted from the machinery spaces to the weather trough over pressure valves which maintain the pressure in the machinery space at a prescribed level lower than that in the citadel .

2.4.6 Access to the machinery spaces shall be through airlocks complying with item [2.2].

2.4.7 Means of exit from machinery spaces for personnel wearing the IPE shall be provided which are also to be provided with decontamination arrangements.

2.4.8 Air pipes to potable water tanks shall be led to citadel or sub-citadel.

2.4.9 The compressor that supply air to self-contained breathing apparatus (SCBA) and to divers apparatus shall be provide with an alternative suction from citadel or sub-citadel to be used in **NBC** stage.

3 Systems

3.1 General

3.1.1 The ship shall be provided with:

a) detection systems of hazard **NBC** products; and

b) sea water and wash-down system; and

c) filtered fresh air ventilation systems.

3.2 Fixed detection system

3.2.1 Radioactivity detection system

The radioactivity detection system shall be capable of measuring the intensity radioactivity outside the citadel or sub-citadel, or sanctuary, as appropriate.

The number and position of radioactivity detector-units capable to detect radioactivity and in addition to the provisions of [3.4.3], shall be at least as follows:

a) one in the atmosphere

b) one outside in the sea water.

The audible and visual alarms of the detector-units shall be positioned in the central damage control station and in the navigating bridge.

3.2.2 Chemical detection system

The chemical detection system shall be capable to detect and identify the chemical agents outside the citadel, sub-citadel, or sanctuary, as appropriate.

The number and position of detector-units capable to detect and identify chemical agents in compliance with item [3.2.2], in addition to the provisions of item [3.4.3], shall be at least as follows :

a) one on mast or similar higher position
b) where appropriate, one on portside and one on starboard of the ship for continuous monitor of the atmosphere outside the citadel, sub citadel, or sanctuary
c) one in the sea water pipe of distillation system for potable water.

The audible and visual alarms of the detector-units shall be positioned in the central damage control station and in the navigating bridge.

3.2.3 Biological system

The biological detection system shall be capable to detect and identify biological agents outside the citadel, sub-citadel or sanctuary.

The number and position of detector-units capable of detect and identify biological agents, in additions to the provisions of [3.4.3], shall be at least as follows:

a) one on mast or similar higher position
b) and where appropriate one on portside and one on starboard of the ship for the continuous monitor of the atmosphere outside the citadel, sub-citadel, or sanctuary
c) one in the sea water pipe of distillation system for potable water.

The audible and visual alarms of detector-units shall be positioned in the central damage control station and in the navigating bridge.

3.3 Sea water wash-down system

3.3.1 Wash-down surfaces

The wash-down system shall give continuous and complete coverage by creating a moving film of water on both vertical and horizontal surfaces of weather deck and superstructure decks.

The selected spray nozzles shall cover weather decks and all equipment installed on weather decks, superstructure surfaces and masts, radomes, etc.

3.3.2 Water supply to wash-down system

The sea water wash-down system shall be fed by fire main. The system shall be divided into section which shall be fed by relevant sections of fire main.

The sections valves shall be operated from the central damage control station. Local operation of the section valve shall also be possible.

3.3.3 Wash-down system capacity

The overall quantity of water to be delivered by the wash-down system is to be assessed assuming a required rate of 3 l/m^2 min for horizontal deck surface and 3 l/m min of vertical surface for each width meter of such surface.

The type and arrangement of open nozzles are to be such that as far as practicable, accounting of ship speed and environment conditions, all parts of the horizontal and vertical concerned surfaces are covered by a wash-down water film, this to be ascertained by a practical trial with ship speed as stated by Naval Authority.

3.4 Fresh air ventilation system in NBC stage

3.4.1 General

The citadel, sub-citadels and the sanctuary are to be provided with either a ventilation system that:

a) shall be converted to provide a pressurized citadel and sub-citadels, or sanctuary, protected from ingress of **NBC** agents by switching the system from ordinary fresh air intake to intake through **NBC** filters; or
b) shall continuously pressurize the citadel and sub-citadels from ingress of **NBC** agents by providing fresh air through filters.

Filter capacity and other facilities for climate control (odour filters and air condition unit) are to be sized in accordance with Naval Authority request for operation performance, such as suitable values for temperature and relative humidity.

3.4.2 Overpressure and air change in NBC stage

The overpressure compared to atmosphere pressure in the citadel, sub-citadel, or sanctuary shall be as stated by the Naval Authority. The ventilation capacity in overpressure of airlocks giving access to the weather deck, for the full time in which the weather door is opened, shall be at least 30 air changes per hour. The cleansing stations are to be ventilated with about 30 air changes per hour.

3.4.3 Ventilation system stations

All openings for air ducted or un-ducted to the weather shall be provided with a gas tight power operated means of closure.

The fresh air intake for NBC stage shall be gastight closed in not NBC stage. The power operation of the means of closure of the air openings to the weather shall be from the central damage control station. Local operation from the inside the citadel, and sub-citadel, or sanctuary, shall also be possible.

The fresh air intake for NBC stage shall be protected by a quick automatically closing air-blast protective device which shall withstand an overpressure of at least of 0,3 bar and shall be positioned as near as possible to the air intake.

The fresh air to citadel, sub-citadel or to sanctuary shall be filtered by filters indicated by Naval Authority.

The ventilation system station shall be arranged to allow the change of filters without leaving the citadel or sub-citadel or the sanctuary.

In the down-stream filter station of fresh air there shall be provided:

a) one radioactivity detector-unit;
b) one detector-unit detecting and identifying chemical agents;
c) one detector-unit detecting and identifying biological agents.

Part E

Additional Class Notations

Chapter 2

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, [7.4.3] 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 stearing machinery may be assured also in case of failure of the remote system control.

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.

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 central damage control stations and the possibility of adjusting its threshold according to the fuel quality is to be provided.

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
(1) A : to be submitted for approval		

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 of Category A as defined in Pt C, Ch 1, Sec 1 and Part C, Chapter 4 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 central damage control station.

3.2.4 The fire detection indicating panel is to be located in the central 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 all central damage control stations.

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
- central damage control 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 central station.

3.3 Fire fighting

3.3.1 Pressurisation 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 central 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.

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 central 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 centralised 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 *(1/1/2017)*

When a diesel engine is used for the propulsion plant, monitoring and control of equipment is to be performed according to Tab 2 for crosshead engines or Tab 3 for trunk piston engines.

4.3 Steam propulsion plants

4.3.1

For steam propulsion plants reference is to be made to the Rules for the Classification of Ships.

Table 2 : Main propulsion crosshead diesel engine *(1/1/2017)*

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						
• Common rail fuel oil pressure	L						
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		

(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) When required by Pt C, Ch 1, Sec 2, [2.3.5].

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
• 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						
• Common rail servo oil pressure	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	
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					

(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) When required by Pt C, Ch 1, Sec 2, [2.3.5].

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
• Scavenging air box temperature (detection of fire in receiver, see [3.2.2])	H	local	X				
• Scavenging air receiver water level	H						
Starting and control air system							
• Starting air pressure before main shut off valve	L	R					
• Control air pressure	L						
• Safety air pressure	L						
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) When required by Pt C, Ch 1, Sec 2, [2.3.5].

Table 3 : Main propulsion trunk piston 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	

(1) When required by Pt C, Ch 1, Sec 2, [2.3.5]. 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.
(4) Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangements may be accepted. Continuous monitoring of inlet pressure and inlet temperature in combination with specific intervals for bearing inspection in accordance with the turbocharger manufacturer's instructions may be accepted as an alternative.

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 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						
• Common rail fuel oil pressure	L						
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					
• Turbocharger lub oil temp. each bearing (4)	H	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						
Starting and control air system							
• Starting air pressure before main shut off valve	L	R					
• Control air pressure	L	R					
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		

(1) When required by Pt C, Ch 1, Sec 2, [2.3.5]. 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.

(4) Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangements may be accepted. Continuous monitoring of inlet pressure and inlet temperature in combination with specific intervals for bearing inspection in accordance with the turbocharger manufacturer's instructions may be accepted as an alternative.

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
• Engine overspeed	H			X			
• Control, safety, alarm system power supply failure	X						

(1) When required by Pt C, Ch 1, Sec 2, [2.3.5]. 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.
(4) Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangements may be accepted. Continuous monitoring of inlet pressure and inlet temperature in combination with specific intervals for bearing inspection in accordance with the turbocharger manufacturer's instructions may be accepted as an alternative.

4.4 Gas turbine propulsion plants

4.4.1 For gas turbines, monitoring and control elements are required according to Tab 4.

4.5 Electrical propulsion plant

4.5.1 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.

4.5.2 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.

4.5.3 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.

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						

4.5.4 Transformers

For transformers, parameters according to Tab 5 are to be controlled or monitored.

4.5.5 Converters

For converters, parameters according to Tab 6, Tab 7 and Tab 8 are to be monitored or controlled.

4.5.6 Smoothing coil

For the converter reactor, parameters according to Tab 9 are to be monitored or controlled.

4.5.7 Propulsion electric motor

For propulsion electric motors, parameters according to Tab 10 are to be monitored or controlled.

4.5.8 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.)

4.6 Shafting, clutches, CPP, gears

4.6.1 For shafting, parameters according to Pt C, Ch 1, Sec 7, Tab 3 are to be monitored or controlled.

4.6.2 For controllable pitch propellers, parameters according to Tab 11 are to be monitored or controlled.

4.6.3 For reduction gears, reversing gears and clutches, parameters according to Pt C, Ch 1, Sec 6, Tab 15 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			

4.7 Auxiliary system

4.7.1

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
- hydraulic control of clutch, CPP or main thrust unit

4.7.2 When a standby machine is automatically started, an alarm is to be activated.

4.7.3 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.

4.7.4 Means shall be provided to keep the starting air pressure at the required level where internal combustion engines are used.

4.7.5 Where daily service fuel oil tanks are filled automatically, or by remote control, means shall be provided to prevent overflow spillages.

4.7.6 Arrangements are to be provided to prevent overflow spillages coming from equipment treating flammable liquids.

4.7.7 Where daily service fuel oil tanks or settling tanks are fitted with heating arrangements, a high temperature alarm shall be provided.

4.7.8 For auxiliary systems, the following parameters, according to Tab 11 to Tab 19 are to be monitored or controlled.

Table 11 : 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					
Control oil pressure	L	R-L				X	
	LL						
Pich position **(1)**	H **(2)** **(3)**	R					
(1) Local manual control is to be available **(2)** High difference from set point **(3)** For feathering propellers, too high pitch value is also to give an alarm							

Table 12 : 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 13 : 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 14 : 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 15 : 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 16 : 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 , which-ever is the lesser.

Table 17 : 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 18 : 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 19 : 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 pressure (preferably before cooler)	L					L	
Oil tank level	L						

4.8 Control of electrical installation

4.8.1 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.

4.8.2 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.

4.8.3 The standby electric power is to be available in not more than 45 seconds.

4.8.4 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.

4.8.5 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.

4.8.6 Monitored parameters for which alarms are required to identify machinery faults and associated safeguards are listed in Tab 20. 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 [5].

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 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 main control station showing which of the subsidiary control stations is indicating a fault condition.

5.1.2 Separation of monitoring and control systems is to be provided.

5.1.3 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.

5.1.4 For computer based system, redundancy will satisfy [5.1.2] and [5.1.3].

5.1.5 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.

5.3 Machinery alarm system

5.3.1 The local silencing of the alarms in the continuously manned central 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.

Table 20 : Auxiliary speed 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						
Common rail fuel oil pressure	L						
Common rail servo oil pressure	L						

(1) Not applicable to emergency generator set.
(2) When required by Pt C, Ch 1, Sec 2, [2.3.5].
One oil mist detector for each engine having two independent outputs for initiating the alarm and shut-down would satisfy the requirement for independence between alarm and shut-down system.
(3) For engine power above 500 kW/cyl.
(4) Only when HFO is used

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.

A suitable alarm is to be activated at the starting of those pumps for which automatic starting is required.

6.1.3

The arrangement for overriding the shutdown of the main propelling machinery is to be such as to preclude inadvertent operation; a suitable alarm is to be activated by their 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 4 h at least
  - The following procedure may, for instance, be chosen: «underway» during 3 h, then increasing 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 4 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 4 h.

SECTION 2 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, [7.4.2] to ships fitted with automated installations enabling periodically unattended operation of machinery spaces and additionally with integrated systems for the control, safety and monitoring of platform systems.

This notation is assigned when the requirements of this Section are complied with in addition to those of 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 up to field I/O excluded a secondary independent means is 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 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 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 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, control and safety 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.

Part E

Additional Class Notations

Chapter 3

MONITORING EQUIPMENT (MON)

SECTION 1 MON-SHAFT-WATER

SECTION 1 MON-SHAFT-WATER

1 General

1.1 Applicability

1.1.1

The additional class notation **MON-SHAFT-WATER** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.5.2], to ships complying with the requirements of this Section.

1.1.2

This notation is assigned only to ships having tailshafts arranged with water lubricated synthetic bearings (including rubber, resin and plastic), a corrosion resistant bronze liner, copper-nickel liner or cladding or a nickel alloy cladding in way of all bearings and between bearings, when the area between bearings cannot be inspected without withdrawal of shaft (e.g in sterntube).

When the area between bearings can be inspected without withdrawal of shaft, this may be protected against contact with seawater by a coating.

1.1.3

The assignment of this notation allows a reduced scope for complete tailshaft surveys; see Pt A, Ch 2, Sec 2, [5.5.4].

2 Requirements for the issuance of the notation

2.1 Arrangement

2.1.1

In order for the notation **MON-SHAFT-WATER** to be granted the bearings are to be arranged with:

- facilities for measurement of bearing wear down,
- at least one position sensor for the aft bearing and all other bearings which are not accessible when the ship is afloat, giving alarm in case of bearing wear down exceeding a predetermined threshold; an alarm is to be activated in the event of failure of the position sensor circuit
- continuous monitoring of the lubricating water flow of the bearings (excluding strut bearings).

2.2 Records

2.2.1

The lubricating water flow, weardown threshold and failure alarms are to be recorded and relevant list is to be kept available on board.

Part E
Additional Class Notations

Chapter 4
OTHER ADDITIONAL CLASS NOTATIONS

SECTION 1 MANOEUVRABILITY (MANOVR-MIL)

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 standard.

In the following a 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 notation **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 irrespectively of their length.

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 stopping test should not exceed 7L.
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.

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].

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:

a) Wind: Not to exceed Beaufort 4 (<7m/s).

b) Wave: Not to exceed sea state 3 ($H_S < 1.25$m).

c) 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.644, section 3.4.2, of June 6, 1994 may be applied. As a minimum following environmental data must be recorded:

a) Water depth.

b) Waves: The sea state should be noted. If there is a swell, period and directions must be noted.

c) 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.

d) 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: Operational condition.

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 [2.2.1].

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.644, 6 June, 1994.

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 HELICOPTER DECK (HELICOPTER)

1 General

1.1 Application

1.1.1 *(1/1/2017)*

The requirements of this Section apply to areas equipped for the landing, take-off of helicopters and parking, and located on a weather deck or on a platform permanently connected to the hull structure.

1.1.2 *(1/1/2017)*

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, [6.6.2] .

1.1.3 *(1/1/2017)*

Ships dealt with in this Chapter are to comply with the requirements stipulated in Parts A, B, C of the Rules and Part D of the Rules for the Classification of Ships, as applicable and with the requirements of this Chapter, which are specific to helicopter deck.

1.1.4 *(1/1/2017)*

In general, the construction of the helicopter decks shall be of steel; the use of aluminium or other low melting point metal construction will be specially considered by the Society.

1.2 Documents to be submitted

1.2.1 *(1/1/2017)*

The documents listed in Tab 1 are to be submitted to the Society.

Table 1 : Documents to be submitted *(1/1/2017)*

No.	I/A **(1)**	Document **(2)**
1	I	General plans showing the position of ship's spaces and flight-deck, 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)
2	I	Main characteristics of helicopter intended to use the helideck (main dimensions, mass and center of gravity, and tyre prints)
3	A	General plan showing the markings to be fitted on the helideck
4	A	Structural plans of the helideck also showing the connection of the helideck with the unit's hull
5	A	Diagram of the fuel supply system
6	A	Structural fire protection, showing the purpose of the various spaces, adjacent helideck & helideck facilities and the fire rating of relevant bulkheads and decks

(1) A : to be submitted for approval
I : to be submitted for information

(2) Plans are to be schematic and functional and to contain all information necessary for their correct interpretation and verification, such as:

- structural scantling
- service pressures
- capacity and head of pumps and compressors, if any
- materials and dimensions of piping and associated fittings
- volumes of protected spaces, for gas and foam fire-extinguishing systems
- surface areas of protected zones for automatic sprinkler and pressure water-spraying, low expansion foam and powder fire-extinguishing systems

All or part of the information may be provided, instead of on the above plans, in suitable operating manuals or in specifications of the systems.

No.	I/A **(1)**	Document **(2)**
7	A	Natural and mechanical ventilation systems of helideck facilities (including ventilation systems serving hazardous spaces) showing: • position of vent inlets and outlets; • penetrations on "A" class divisions; • location of dampers; • means of closing; • arrangements of air conditioning rooms; • location of fan controls; • air changes per hour (where requirements for air changes per hour are set)
8	A	Automatic fire detection systems
9	A	Diagram of low expansion foam fire-extinguishing systems for flight-deck
10	A	Fire-fighting equipment and firemen's outfits
11	A	Plan of hazardous areas relevant to hangar and refuelling installations
12	A	Documents giving details of types of cables and safety characteristics of the equipment installed in the hazardous areas mentioned in 11 above
13	A/I	Characteristics and calculations for fixed manoeuvring system, if fitted

(1) A : to be submitted for approval
I : to be submitted for information

(2) Plans are to be schematic and functional and to contain all information necessary for their correct interpretation and verification, such as:
- structural scantling
- service pressures
- capacity and head of pumps and compressors, if any
- materials and dimensions of piping and associated fittings
- volumes of protected spaces, for gas and foam fire-extinguishing systems
- surface areas of protected zones for automatic sprinkler and pressure water-spraying, low expansion foam and powder fire-extinguishing systems

All or part of the information may be provided, instead of on the above plans, in suitable operating manuals or in specifications of the systems.

2 Helideck lay-out

2.1 General

2.1.1 *(1/1/2017)*

The construction of the helidecks is to be of steel or other equivalent metallic materials, i.e. any non-combustible metallic material which, by itself or due to insulation provided (e.g. aluminium alloy with appropriate insulation), has structural and integrity properties equivalent to steel at the end of the applicable exposure to the standard fire test (see Note 1). Where the Society permits aluminium or other low melting point metal construction, items [4.2.1] a) to c) are also to be taken into account.

Note 1: Refer to the "International Code for Application of Fire Test Procedures" (FTP Code), as adopted by the Maritime Safety Committee of IMO by Resolution MSC.61 (67), as may be amended by IMO.

2.2 Definitions

2.2.1 *(1/1/2017)*

a) ″For the purpose″ of this section, helideck is a purpose-built helicopter landing area located on a ship including all structure, fire-fighting appliances and other equipment necessary for the safe operation of helicopters.

b) Helicopter facilities is a helideck including any refuelling and hangar facilities.

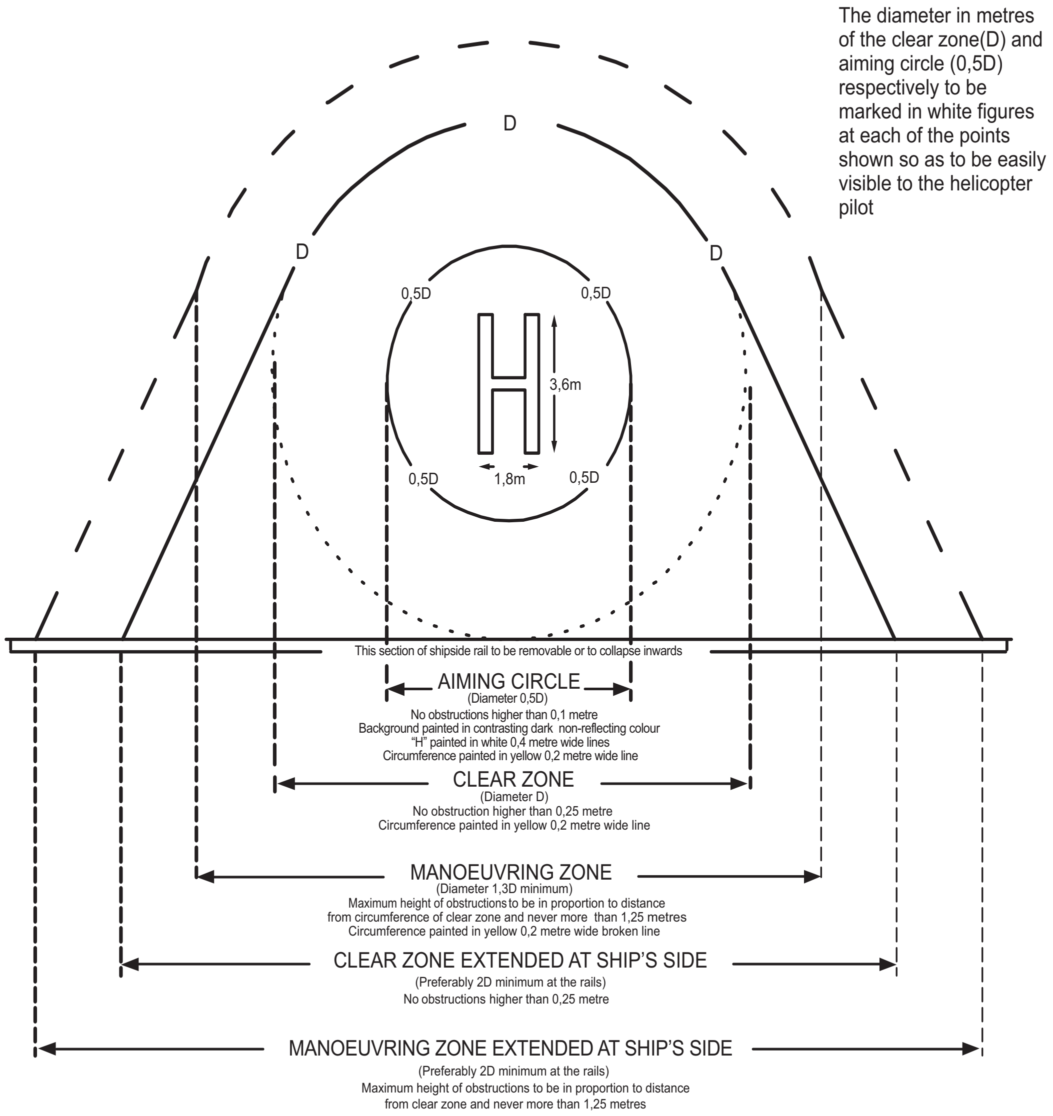
″Diameter (d)″ means the overall length of the helicopter with the rotors turning. The maximum value of ″d″ will depend on the type and size of the helicopter. This is to be agreed by the Society taking into account the particulars of the ship and its area of operation.

2.3 Landing area

2.3.1 General *(1/1/2017)*

Unless otherwise stated by the Naval Authority, the arrangement of helicopter deck is to be in accordance with the present paragraph.

Figure 1 : Landing area layout *(1/1/2017)*



2.3.2 Aiming circle (touchdown zone) *(1/1/2017)*

The aiming circle is an area concentric to the centre of the clear zone and has a diameter half that of the clear zone itself. The circle is to accommodate with safety the landing gear of helicopters for which it is intended and, if possible, be completely obstruction-free. If there are unavoidable obstructions, they are to have rounded edges capable of being traversed without damaging the landing gear of a helicopter, and are to be no higher than 0,1 m.

The aiming circle is to be completely covered with a matt anti-slip surface painted in a dark non-reflecting colour which contrasts with the other deck surfaces. Its circumference is to be marked with a yellow line 0,2 m wide, with the diameter in metres of the aiming circle clearly indicated in white figures at four points in the circumference line as shown in Fig 1.

The letter 'H' is to be painted at the centre of the aiming circle in 0,4 m wide white lines forming a letter of dimensions 3,6 x 1,8 m.

2.3.3 Clear zone *(1/1/2017)*

The diameter of the clear zone will depend upon the available landing area. The clear zone is however to be as large as practicable recognizing that its diameter D is to be greater than the overall length, with rotors turning, of the biggest helicopter designed to use the landing area (d).

The circumference of the clear zone is to be marked by a yellow line of 0,2 m width, with the diameter D in metres indicated in white figures at points in the circumference line as shown in Fig 1.

There are to be no fixed obstructions in the clear zone higher than 0,25 m.

2.3.4 Manoeuvring zone *(1/1/2017)*

The maneuvering zone of the landing area extends the area in which a helicopter may maneuver with safety by enlarging, to a diameter of at least 1,3D, the area over which the rotors of the helicopter may overhang without danger from high obstructions.

If it is impossible to remove all obstructions from the manoeuvring zone, a graduated increase in the permitted height of obstructions, from 0,25 m at the circumference of the clear zone to a maximum of 1,25 m at the circumference of the manoeuvring zone, is acceptable. However, such height above 0,25 m is not to exceed a ratio of one to two in relation to the horizontal distance of the obstruction from the edge of the clear zone (see Fig 2). All obstructions in the manoeuvring zone are to be clearly marked in contrasting colours.

To assist the helicopter pilot in his positioning, the circumference of the manoeuvring zone is to be indicated by a broken yellow line of 0,2 m width (see Fig 1).

2.3.5 Use of landing area for other purposes *(1/1/2017)*

It is considered that helicopter landing areas may be used for other purposes in normal circumstances. In the event of need, it is to be possible to clear this area readily.

2.3.6 Night operations: Lighting *(1/1/2017)*

Adequate lighting is to be arranged for the landing area in such a way to not be directed towards the helicopter and to not interfere with Night Vision Goggles.

In addition, illumination is to be provided for obstructions in the manoeuvring zone and for adjacent superstructures.

2.3.7 Drainage system *(1/1/2017)*

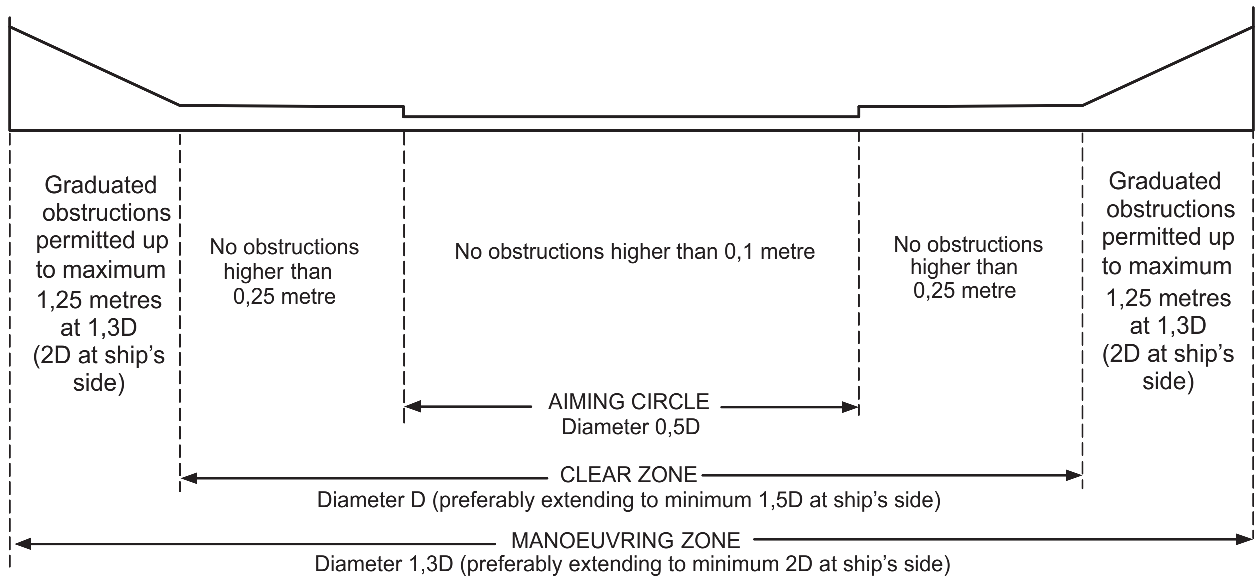
Gutter-ways of adequate height and a drainage system are to be provided on the periphery of the helideck.

Drainage facilities are to be provided for railways and other recess (e.g. landing grid) in helicopter deck.

Drainage facilities in way of helidecks shall be constructed of steel and lead directly overboard independent of any other system and designed so that drainage does not fall on to any part of the ship.

Provision are to be taken to avoid liquids to enter into the ship or in the hangar through tracks for helicopter handling.

Figure 2 : Landing area - permitted height of obstructions (elevation) *(1/1/2017)*



3 Structural design and scantling

3.1 General and symbols

3.1.1 General *(1/1/2017)*

Local deck strengthening is to be fitted at the connection of diagonals and pillars supporting platform.

3.1.2 Symbols *(1/1/2017)*

W_H : Maximum weight of the helicopter, in t

g : Gravity acceleration, in m/s^2

Ry : Minimum yield stress, in N/mm^2, of the material, to be taken equal to 235/k N/mm^2, unless otherwise specified

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

3.2 Design loads

3.2.1 General *(1/1/2017)*

The characteristics of the helicopters intended to use the helideck, i.e. main dimensions, mass and centre of gravity, and tyre prints, are to be provided by the designer.

3.2.2 Landing area located on a weather deck *(1/1/2017)*

The following loads are to be considered for the scantlings of the helicopter deck:

- landing load defined in [3.4],
- garage load, if any, defined in [3.5],
- loads due to ship accelerations and wind defined in [3.6].

3.2.3 Landing area located on a platform *(1/1/2017)*

The following loads are to be considered for the scantlings of the helicopter deck:

- sea pressure defined in [3.3],
- landing load defined in [3.4],
- garage load, if any, defined in [3.5],
- loads due to ship accelerations and wind on platform supporting structures defined in [3.6].

3.2.4 Helicopter having landing devices other than wheels *(1/1/2017)*

In the case of a deck or a platform intended for the landing of helicopters having landing devices other than wheels (e.g. skates), the landing load, the emergency landing load and the garage load, if any, will be examined by the Society on a case-by-case basis.

3.2.5 Fixed Manoeuvring system loads *(1/1/2017)*

The manoeuvring system load, defined in [3.7], is to be considered for the scantlings of the helicopter manoeuvring track.

3.3 Sea pressure

3.3.1 *(1/1/2017)*

The sea pressure acting on a landing platform is to be obtained according to Pt B, Ch 5, Sec 5, [2.1.2].

3.4 Landing load

3.4.1 *(1/1/2017)*

The landing load transmitted through one tyre to the deck or the platform is to be obtained, in kN, from the following formula:

$F_{CR} = 0{,}75 g W_H$

3.4.2 *(1/1/2017)*

Where the upper deck of a superstructure or deckhouse is used as a helicopter deck and the spaces below are quarters, the bridge, control room or other normally manned service spaces, the value of the landing load defined in [3.4.1] is to be multiplied by 1,15.

3.5 Garage load

3.5.1 *(1/1/2017)*

Where a garage zone is fitted in addition to the landing area, the still water and inertial forces transmitted through the tyres to the deck or the platform in the garage zone are to be obtained, in kN, as specified in Pt B, Ch 5, Sec 6, [6.1.1], where M is to be taken equal to 0,5 W_H.

3.6 Forces due to ship accelerations and wind

3.6.1 *(1/1/2017)*

The still water and inertial forces applied to the deck or the platform are to be determined on the basis of the forces obtained, in kN, as specified in Tab 2.

3.7 Fixed Manoeuvring system load

3.7.1 *(1/1/2017)*

Where a fixed manoeuvring system is fitted, the inertial forces transmitted through the track to the deck in the manoeuvring zone are to be obtained by seakeeping analysis taking into account the operative limits of the system.

3.7.2 *(1/1/2017)*

The functional load due to the manoeuvring, to be specified by the system Manufacturer, is to be considered for the scantlings of the helicopter manoeuvring track:

3.8 Net scantling

3.8.1 *(1/1/2017)*

As specified in Pt B, Ch 4, Sec 2, [1], all scantlings referred to in this Section are net, i.e. they do not include any margin for corrosion.

The gross scantlings are obtained as specified in Pt B, Ch 4, Sec 2, [1].

3.9 Plating

3.9.1 Load model for landing area located on a weather deck *(1/1/2017)*

The following loads transmitted by tyre prints are to be considered:

- landing load, as defined in [3.4],
- garage load, if any, as defined in [3.5].

3.9.2 Load model for landing area located on a platform *(1/1/2017)*

The following loads are to be considered independently:

- sea pressure, as defined in [3.3],
- loads transmitted by tyre prints,
- landing load, as defined in [3.4],
- garage load, if any, as defined in [3.5].

3.9.3 Plating subjected to sea pressure *(1/1/2017)*

The net thickness of the landing area plating subjected to sea pressure is to be not less than that obtained from the formulae in Pt B, Ch 7, Sec 1, [3].

3.9.4 Plating subjected to landing load or garage load *(1/1/2017)*

The net thickness of the landing area plating subjected to landing load or garage load, if any, transmitted by tyre prints, is to be not less than that obtained from the formulae in Pt B, Ch 7, Sec 1, [4.3], considering the wheeled load as being calculated according to [3.8.1] or [3.8.2], as applicable.

Where the print area is not specified by the Designer, a 300x300 mm print area is to be taken into account.

Table 2 : Still water and inertial forces *(1/1/2017)*

Ship condition	Load case	Still water force F_S and inertial force F_W, in kN
Still water condition		$F_S = (W_H + W_P)g$
Upright condition	"a"	No inertial force
	"b"	$F_{W,X} = (W_H + W_P)\ a_{X1} + 1,2\ A_{HX}$ in x direction $F_{W,Z} = (W_H + W_P)\ a_{Z1}$ in z direction
Inclined condition (negative roll angle)	"c"	$F_{W,Y} = C_{FA}(W_H + W_P)\ a_{Y2} + 1,2\ A_{HY}$ in y direction
	"d"	$F_{W,Z} = C_{FA}(W_H + W_P)\ a_{Z2}$ in z direction

Note 1:

W_P : structural weight of the platform, in t, to be evenly distributed, and to be taken not less than the value obtained from the following formula:
$W_P = 0,2\ A_H$

A_H : area, in m², to be obtained projecting on A horizontal plane parallel to the summer load waterline the entire landing area considering also possible helideck supporting structures outside the landing area

a_{x1}, a_{z1} : accelerations, in m/s², determined at the helicopter centre of gravity for the upright ship condition, and defined in Ch 5, Sec 3, [3.4]

a_{Y2}, a_{Z2} : accelerations, in m/s², determined at the helicopter centre of gravity for the inclined ship condition, and defined in Ch 5, Sec 3, [3.4]

A_{HX} : area, in m², to be obtained projecting on a transversal plane perpendicular to the summer load waterline the helideck supporting structures (including the helideck platform)

A_{HY} : area, in m², to be obtained projecting on a longitudinal plane parallel to the centreline plane of the ship the helideck supporting structures (including the helideck platform)

C_{FA} : Combination factor, to be taken equal to:
- C_{FA} = 0,7 for load case "c"
- C_{FA} = 1,0 for load case "d"

3.10 Ordinary stiffeners

3.10.1 Load model for landing area located on a weather deck *(1/1/2017)*

The following loads are to be considered independently:

- landing load defined in [3.4],
- garage load, if any, defined in [3.5],
- loads due to ship accelerations and wind defined in [3.6]
- fixed manoeuvring system load, as defined in [3.7].

3.10.2 Load model for landing area located on a platform *(1/1/2017)*

The following loads are to be considered independently:

- sea pressure, as defined in [3.3],
- loads transmitted by tyre prints,
- landing load defined in [3.4],
- garage load, if any, as defined in [3.5],
- loads due to ship accelerations and wind defined in [3.6].

3.10.3 Normal and shear stresses *(1/1/2017)*

Normal and shear stresses induced by loads and pressures in an ordinary stiffener are to be obtained according to:

- Pt B, Ch 7, Sec 2, [3.4] for an ordinary stiffener subjected to sea pressure,
- Pt B, Ch 7, Sec 2, [3.5] for an ordinary stiffener subjected to loads transmitted by tyre prints.

3.10.4 Checking criteria *(1/1/2017)*

It is to be checked that the normal stress σ and the shear stress τ calculated according to [3.10.3], are in compliance with the following formulae:

$$\frac{R_y}{\gamma_R \gamma_m} \geq \sigma$$

$$0,5\frac{R_y}{\gamma_R \gamma_m} \geq \tau$$

where:

γ_m : partial safety factor covering uncertainties on the material, to be taken equal to 1,02

γ_R : partial safety factor covering uncertainties on the resistance to be taken equal to 1,15.

3.11 Primary supporting members

3.11.1 Load model for landing area located on a weather deck *(1/1/2017)*

The following loads are to be considered independently:

- loads transmitted by tyre prints,
- landing load defined in [3.4],
- garage load, if any, defined in [3.5],
- loads due to ship accelerations and wind defined in [3.6]
- fixed manoeuvring system load, as defined in [3.7].

3.11.2 Load model for landing area located on a platform *(1/1/2017)*

The following loads are to be considered independently:

- sea pressure, as defined in [3.3],
- loads transmitted by tyre prints,
- landing load defined in [3.4],
- garage load, if any, defined in [3.5],
- loads due to ship accelerations and wind defined in [3.6].

3.11.3 Normal and shear stresses *(1/1/2017)*

Normal and shear stresses induced by loads and pressures in a primary supporting member are to be obtained according to Pt B, Ch 7, App 1, [5], considering:

- $\sigma = \max(\sigma_1, \sigma_2)$ and $\tau = \tau_{12}$, for analyses based on finite element models,
- $\sigma = \sigma_1$ and $\tau = \tau_{12}$, for analyses based on beam models.

3.11.4 Checking criteria *(1/1/2017)*

It is to be checked that the normal stress and the shear stress calculated according to [3.11.3], are in compliance with the following formulae:

$$\frac{R_y}{\gamma_R \gamma_m} \geq \sigma$$

$$0,5\frac{R_y}{\gamma_R \gamma_m} \geq \tau$$

where:

γ_m : partial safety factor covering uncertainties on the material, to be taken equal to 1,02

γ_R : partial safety factor covering uncertainties on the resistance to be taken equal to 1,15.

4 Finite element models

4.1

4.1.1 *(1/1/2017)*

In lieu of the requirements provided in [3.9] and [3.10], scantling of plating and ordinary stiffeners may be carried out by means of analysis based on finite element models of the deck.

The loads to be applied are those indicated above.

It is to be checked that the normal stress and the shear stress calculated according to [3.11.3], are in compliance with the following formulae:

- plating:

$$R_y C_0 > \sigma$$

where:

C_0 : is a deck function coefficient that takes into account a certain amount of allowable permanent set; C_0 is to be taken equal to or greater than 1 and its value is to be agreed by the Society with the Naval Authority.

- ordinary stiffeners:

$$\frac{R_y}{\gamma_R \gamma_m} \geq \sigma$$

$$0,5\frac{R_y}{\gamma_R \gamma_m} \geq \tau$$

where:

γ_m : partial safety factor covering uncertainties on the material, to be taken equal to 1,02

γ_R : partial safety factor covering uncertainties on the resistance to be taken equal to 1,15.

Where a fixed manoeuvring system is fitted, in addition to the loads defined in [3.7] a clearance check is to be carried out in the worst operative condition.

The hull system deformation has not to exceed the geometrical functional clearance of the fixed manoeuvering system defined by the manufacturer.

In addition the stress is to be in the elastic range.

5 Use of other recognised standards

5.1

5.1.1 *(1/1/2017)*

In lieu of the requirements of [3], scantling of helicopter deck may be carried out in accordance with the procedure of the Design Data Sheet, DDS 130-2 (Structural Analysis of Helicopter Flight and Hangar Decks) of the US Navy provided that the following information on the helicopter are available:

- Helicopter weights (maximum load Wm and parking load Wp) and relevant centre of gravity
- Helicopter gear reaction (recommended; if not available to be assumed 2,67 Wm)
- Helicopter sail area and relevant centre of pressure
- Tyre footprint variation against load
- Tiedown and/or RAST layout.

The ship motion force in storm seas may be calculated in accordance with Pt B, Ch 5, Sec 6, [4.1.2], where M is to be taken equal to the gear reaction on the tyre(s) under examination; otherwise, ship motion forces may be calculated by means of ad-hoc sea-keeping calculation performed in accordance with the requirements for the assignment of the additional class notation **SEA-KEEP-FLY**.

Other recognised standards will be considered by the Society on a case by case basis.

6 Helicopter refuelling and hangar facilities

6.1 Fuel storage system

6.1.1 Storage area *(1/1/2017)*

The fuel oil for refuelling helicopters shall either have a flash point greater than 60°C, or be JP5-NATO (F44).

Such fuel shall be stored in structural tanks as required in Pt C Chapter 1 for ship fuel oil systems.

The helicopter fuel oil system components shall be as remote as practicable from accommodation spaces and escape route.

The helicopter fuel oil pumps shall be fitted in ship fuel oil pump room and be capable of being automatically started from helicopter refuelling station by the refuelling device.

The fuel pumping system shall incorporate a device which will prevent over-pressurization of the delivering hose.

Fixed arrangements are to be provided at the refuelling station for filtering and sampling.

6.1.2 Fuel tanks *(1/1/2017)*

Tanks and associated equipment are to be protected against physical damage and from a fire in an adjacent space or area.

JP5 fuel tanks shall be separated from machinery spaces, accommodations and service spaces, drinking water and provisions intended for human consumption, by a cofferdam, a void space, a void tank or any other space of same nature.

Where accommodation and service spaces are arranged immediately above JP5 fuel tanks, the cofferdam may be omitted only where the deck is not provided with access openings and is coated with a layer of material recognized as suitable by the Society.

When JP-5 fuel tanks are adjacent to an ammunition hold or any other space which may lead to a potential dangerous reaction, they shall be separated from it by a cofferdam.

6.1.3 Fuel pumping *(1/1/2017)*

Storage tank fuel pumps shall be provided with means which permit shutdown from a safe remote location in the event of fire. Gravity fed fuelling systems is not permitted.

The fuel pumping unit shall be connected to one tank at a time. The piping between the tank and the pumping unit shall be of steel or equivalent material, as short as possible, and protected against damage.

Electrical fuel pumping units and associated control equipment shall be of a type suitable for the location and potential hazards.

Fuel pumping units shall incorporate a device which will prevent over-pressurization of the delivery or filling hose.

6.1.4 Refuelling equipment *(1/1/2017)*

All equipment used in refuelling operations shall be electrically bonded.

6.2 “No smoking" signs

6.2.1 *(1/1/2017)*

"No smoking" signs shall be displayed at appropriate locations.

6.3 Refuelling stations

6.3.1 *(1/1/2017)*

Refuelling stations are to be as category A machinery spaces with regard to structural fire protection, fixed fire extinguishing and detection system and are to be provided with mechanical ventilation capable of providing at least 10 air changes per hour; ventilation fans shall be of non-sparking type.

Manually operated call points shall be provided close to the exit of the refuelling stations.

Note 1: In this Section, the wording "refuelling station" means an enclosed space containing piping and equipment wich are permanently connected to the ship's refuelling system and do not include the space dedicated for the storage of refuelling equipment such as fuel hoses and nozzles without any connection to the fuel piping.

6.4 Refuelling and JP5-NATO (F44) pump room(s)

6.4.1 *(1/1/2017)*

The JP5-NATO (F44) transferring and refuelling system when present on board shall comply with the requirements of Pt D, Ch 2, Sec 4, [3.6] and Pt D, Ch 2, Sec 4, [4].

7 Electrical equipment and wiring

7.1

7.1.1 *(1/1/2017)*

Electrical equipment and wiring in the refuelling room shall be of type suitable for use in an explosive petrol and air mixture. For the purpose of this requirement, due regard is to be provided to their location, risk of presence of explosive or flammable vapours and means of ventilation provided. The Society may refer to the International Electrotechnical Commission, in particular Publication 60079.

The space is to be considered as hazardous zone 1.

Hangars without refuelling facilities are to be considered as zone 1 up to 450 mm from the deck, the remaining areas are to considered as zone 2.

Where it is impossible to install equipment suitable for the intended zone, or due to the operations performed in the hangar, e.g. maintenance, a gas detection system is to be fitted.

The gas detection system shall give an alarm when 30% of the lower explosive limit (LEL) is reached and de-energize the space at 60 % of the space. In any case fire detection sensors and ventilation fans are to be suitable for zone 1.

The number and arrangement of the sensors will be evaluated by the Society on a case by case basis, depending on the layout of the spaces, in any case at least two sensors are to be fitted.

8 Fire protection

8.1

8.1.1 Ventilation *(1/1/2017)*

a) Enclosed hangar facilities or enclosed spaces containing refuelling installations are to be provided with mechanical ventilation complying with these requirements.

b) The system is to be capable of:
   - providing 6 air changes per hour;
   - preventing air stratification and the formation of air pockets;
   - being controlled from a position outside the spaces served.

c) Ventilation fans are to be of non-sparking type and are normally to be run continuously whenever helicopters are on board. Where this is impracticable, they are to be operated for a limited period daily as weather permits and in any case for a reasonable period prior to discharge, after which period the hangar facilities or enclosed spaces containing refuelling installations are to be proved gas-free. At least one portable combustible gas detecting instrument is to be carried for this purpose.

d) Means are to be provided on the navigation bridge to indicate any loss of the required ventilating capacity.

e) Ventilation ducts, including dampers, are to be made of steel and are to be capable of being effectively sealed for each space served.

f) Arrangements are to be provided to permit a rapid shutdown and effective closure of the ventilation ducts and openings from outside of the space served in case of fire, taking into account the weather and sea conditions.

9 Fire-fighting appliances

9.1

9.1.1 General *(1/1/2017)*

In order to protect the helideck against an helicopter crash, the following fire-fighting appliances shall be provided and in any case in position not interfering with helicopter operations:

a) a suitable foam application system consisting of monitors or foam making branch pipes capable of delivering foam to all parts of the helideck in all weather conditions in which the helicopter can operate. The system shall be capable of delivering a discharge rate as required in Tab 3 for at least five minutes.

   The principal agent is to meet the applicable performance standards of the International Civil Aviation Organization - Airport Services Manual, Part 1 - Rescue and Firefighting, Chapter 8 - Extinguishing Agent Characteristics, Paragraph 8.1.5 - Foam Specifications Table 8-1, Level B foam, and be suitable for use with salt water. As an alternative, the principal agent may conform to STANAG 7183 - The Minimum Crash, Fire Fighting and Rescue (CFR) Equipment Standards for Aviation Capable Vessels as required by the Naval Authority:

   If the ship is provided with prewetting system for NBC protection, the branch pipes serving the helideck may be used also for the purpose of the foam application system provided that discharge rate and coverage required in above par a) are fulfilled with.

   If the helideck is subdivided in different landing spots, the foam system is to be sectioned accordingly.

   When the helicopter deck is intended for the simultaneous operation of two or more helicopters, the capacity of the foam system is to be such as to ensure the required discharge rate and time for all the landing spots engaged in operation.

b) carbon dioxide extinguishers of a total capacity of not less than 18 kg or equivalent.

c) at least two dry powder extinguishers having a total capacity of not less than 45 kg.

d) at least two nozzles of an approved dual-purpose type (jet/spray) and two hose lengths, complying with Pt C, Ch 4, Sec 6, [1.2.5] and Sec 6, [1.4.3], capable to reach any part of the helideck.

e) There shall be provided fire rescue outfits and rescue equipment, in number and type, as stated by Naval Authority.

9.1.2 *(1/1/2017)*

In close proximity of the helideck, at least the following equipment shall be stored in a manner that provides for immediate use and protection from the elements:

- adjustable wrench;
- blanket, fire-resistant;
- cutters, bolt 60 cm;
- hook, grab or salving;
- hacksaw, heavy duty complete with 6 spare blades;
- ladder;
- lift line 5 mm diameter x 15 m in length;
- pliers, side cutting;
- set of assorted screwdrivers; and
- harness knife complete with sheath.

Table 3 : Foam solution discharge rate *(1/1/2017)*

Category	Helicopter overall length	Foam solution discharge rate (litres/min)
H1	Less than 15 m	250
H2	At least 15 m but less than 24 m	500
H3	At least 24 m but less than 35 m	800

10 Means of escape

10.1

10.1.1 *(1/1/2017)*

A helideck, which is not on main deck, shall be provided with both a main and an emergency means of escape and access for fire-fighting and rescue personnel; these shall be located as far apart from each other as is practicable and preferably on opposite sides of the helideck.

11 Operations manual

11.1 General

11.1.1 *(1/1/2017)*

9.1.1Each helicopter facility shall have an operations manual, including a description and a checklist of safety precautions, procedures and equipment requirements. This manual may be part of the ship's emergency response procedures.

SECTION 3 EQUIPMENT (MOORING)

1 General

1.1 Application

1.1.1

The requirements of this Section are applicable for the assignment of the additional class notation **MOORING**.

They are additional to the applicable requirements of Pt B, Ch 9, Sec 4, [3.5] failing owner advise to the contrary.

1.2 Mooring lines

1.2.1

Ships require mooring lines as specified in Tab 1. The breaking loads defined in Tab 1 refer to synthetic fibre ropes.

The breaking load of natural fibre ropes or wire can be optained according item Pt B, Ch 9, Sec 4, [3.5.6] of the rules.

1.2.2

Mooring ropes are to be tested and certified in accordance with Pt D, Ch, 4, Sec 1 of the Rules for the Classification of Ships.

1.3 Bollards and fairleads

1.3.1

Means are to be provided to enable mooring lines to be adequately secured on board ship. It is recommended that the total number of suitably placed bollards on either side of the ship and/or the total brake holding power of mooring winches should be capable of holding not less than 1,5 times the sum of the maximum breaking strengths of the mooring lines required.

1.3.2

The seating arrangements and supporting hull structure for bollards and fairleads are to be efficiently constructed and adequate for the intended loads.

1.4 Mooring winches

1.4.1

Mooring winches are to be suitable for the intended purpose. Supports under the winches are to be to the Surveyor's satisfaction. They should be fitted with drum brakes, the strength of which is sufficient to prevent unreeling of the mooring line when the rope tension is equal to 80 per cent of the breaking strength of the rope as fitted on the first layer on the winch drum.

1.4.2

The maximum hauling tension which can be applied to the mooring lines (the reeled first layer) should not be less than 1/4,5 times the rope's breaking strength and not more than 1/3 times the rope's breaking strength. For automatic winches these figures shall apply when the winch is set on the maximum power with automatic control.

1.4.3

The winch is to be tested in shop or on board and it is to be marked with the range of rope strength for which it is designed.

Table 1

Δ (t)	N	Length of each line (m)	Breaking load (kN)
25.000 - 30.000	16	200	689
20.000 - 25.000	8	200	630
13.000 - 20.000	8	200	569
9.000 - 13.000	8	200	569
5.550 - 9.000	8	200	453
2.150 - 5.500	8	200	406
1.050 - 2.150	8	200	272
400 - 1.050	4	200	195

Δ : Displacement at full load

SECTION 4 LIFTING APPLIANCES (LA)

1 General

1.1 General

1.1.1 Applicability

This Section provides the criteria for the assignment of the additional class notation **LA** in accordance with Pt A, Ch 1, Sec 2, [7.6.3], to ships equipped with lifting appliances certified by Tasneef in compliance with the requirements of this Section.

1.1.2 Definition of lifting appliances *(1/1/2017)*

The lifting appliances that may be considered for the assignment of the LA notation are the following:

a) Cranes, derricks and elevators intended for the handling of cargoes including vehicles without persons on board;

b) Cranes, intended for the handling service boats with embarked persons;

c) Launching appliances for survival crafts;

d) Elevators for the handling of cargoes and persons (e.g. helicopter with embarked crew);

e) Lifts for persons;

f) RAS stations.

1.2 Assumption

1.2.1

Unless otherwise specified by the Naval Authority, it is to be assumed that lifting appliances listed in [1.1.2] items a) and g) are to be intended for use in harbour or sheltered water environment whilst lifting appliances listed in [1.1.2] items b) to f) are to be intended for use in open sea.

1.2.2

Unless otherwise specified by the Naval Authority, the dynamic forces do to ship motion are those deriving from the accelerations calculated in accordance with Pt B, Ch 5, Sec 3 under the following conditions, assuming ship motions as acting simultaneously:

a) in the case of moving lifting appliance:

- rolling acceleration α_R, as defined in Pt B, Ch 5, Sec 3, [2.4.1], assuming, A_R = 10° e T_R = 10 s;
- pitching acceleration a_P, as defined in Pt B, Ch 5, Sec 3, [2.5.1], assuming A_P = 7,5° e T_P = 7 s;

b) in the case of stationary lifting appliance:

- rolling acceleration α_R, as defined in Pt B, Ch 5, Sec 3, [2.4.1], assuming A_R = 22,5° e T_R = 10 s;
- pitching acceleration σ_P, as defined in Pt B, Ch 5, Sec 3, [2.5.1], assuming A_P = 7,5° e T_P = 7 s;
- heaving acceleration a_H, as defined in Pt B, Ch 5, Sec 3, [2.3.1].

In addition, in order to take account of dynamic forces due to tripping of safety gear for stopping of lifting appliance, the weight and the rated load are to be multiplied by a dynamic factor F_d, whose value is to be clearly specified and justified by the Designer. Tasneef reserves the right to increase the above-mentioned dynamic factor whenever deemed appropriate in relation to the calculations submit-ted for its determination.

1.3 Documents to be submitted

1.3.1

The documents listed in Tab 1 are to be submitted in addition to the documentation required by the other applicable Rules.

Table 1 : Documents to be submitted

No.	I/A (1)	Document
1	I	General arrangement of all the Lifting appliances covered by LA notation with indication of: • Intended service • SWL and operating limitation, if any • Loose gears list and relevant SWL
2	A	SWL and operating limitation, if any

(1) A = to be submitted for approval;
I = to be submitted for information.

1.4 Hull structural arrangements related to lifting appliances

1.4.1 General

The hull structures related to the arrangement of lifting appliances on the ship are to be designed with adequate strength and stiffness to sustain the loads induced by the system during rest and operation, in accordance with the general load and strength criteria in Pt B, Ch 7, App 1.

Pedestals and foundations also concern the ship's hull and are to comply with the above structural strength requirements.

2 Certification of lifting appliances

2.1 General

2.1.1

For the assignment of LA notation, all the lifting appliances as defined in [1.1.2] that are installed on-board are to be approved and tested by Tasneef in accordance with the requirement of this Section.

For launching appliances for survival crafts, a test certificate issued in accordance with [2.4] by a notified body other than Tasneef may be accepted.

Upon specific request of the Naval Authority, some lifting appliances may be excluded for the application of the requirements of this section (e.g. in case of appliances built in accordance with military standards); in such case, the field of applicability of the **LA** notation is to be detailed in the "remarks" field of the Certificate of Class.

2.2 Cranes, derricks and elevators intended for the handling of cargoes including vehicles without persons on board

2.2.1

Cranes, derricks and elevators intended for the handling of cargoes including vehicles without persons on board are to be certified according to the Tasneef "Rules for loading and unloading arrangements and for other lifting appliances on board ships".

2.3 Cranes, intended for the handling of service boats with embarked persons

2.3.1

Cranes which are certified in accordance with the present paragraph [2.3] are not to be intended to be used launching appliances for survival crafts.

2.3.2

Cranes, intended for the handling service boats with embarked persons are to be certified according to the Tasneef "Rules for loading and unloading arrangements and for other lifting appliances on board ships" together with the following additional requirements:

a) the lifting appliance and its attachments other than winch brakes are to be of sufficient strength to withstand a static proof load on test of not less than 2.2 times the maximum working load;

b) in respect of the factor of safety on the basis of the maximum working load and the ultimate strengths of the materials used for construction, a minimum factor of safety of 4,5 is to be applied to all structural members and a minimum factor of safety of 6 is to be applied to falls, suspension chains, links, blocks and, in general, to all loose gears;

c) the lifting appliance structure is to be overload tested at the manufacturer by applying a static proof load of 2,2 times the maximum working load; the load is to be swung through an arc of approximately 10° to each side of vertical in the fore and aft plane; there is not to be evidence of significant deformation or other damage as a result of this test. In case of serial production, this overload test may be carried out only on the first certified crane.

d) after installation on board, the lifting appliance is to be overload tested by applying a static test load of 1,5 times the maximum working load with the winch drums wound at the maximum number of turns permitted and the load is to be held by the brake.

2.4 Launching appliances for survival crafts

2.4.1 *(1/1/2017)*

Cranes, derricks and elevators intended for the handling of cargoes including vehicles without persons on board are to be certified according to IMO Life Saving Appliances Code, LSA.

2.5 Elevators for the handling of cargoes and persons

2.5.1

The elevators which are certified in accordance with the present paragraph [2.5] are not to be intended to be used common means for personnel transit among ship's spaces (for lifts see [2.6]); the use of elevators for handling of persons is allowed in these cases:

- handling of helicopters, aircrafts or vehicles with embarked crew;
- handling of fork-lifts with embarked driver;
- handling of stretchers with hospitalised personnel and medical staff to and from hospital areas.

2.5.2

Elevators for the handling of cargoes and persons are to be certified according to the Tasneef "Rules for loading and unloading arrangements and for other lifting appliances on board ships" together with the following additional require-ments:

a) the "first case" indicated in Sec 5, [2.1.1] of the Tasneef "Rules for loading and unloading arrangements and for other lifting appliances on board ships" is to include ship motion dynamic forces as defined in the above [1.1.2].

b) the allowable deflection f_{amm}defined in Sec 5, [3.1.1] of the Tasneef "Rules for loading and unloading arrange-ments and for other lifting appliances on board ships", is to be taken equal to:
   - 0,0017 L for the platform;
   - 0,0025 L for guide rails but in no case to be taken greater than 5 mm.

c) the safety factor n for steel wire ropes as defined in Ch 7, [5.2.1] of the Tasneef "Rules for loading and unloading arrangements and for other lifting appliances on board ships", is to be taken not less than 6 in respect of the maximum loading condition with persons

d) when used for handling of stretchers and medical staff the platform is to be fitted with movable guard rails in accordance with Pt B, Ch 9, Sec 2, [3.1.2] in order to prevent falling from platform; equivalent solutions may be considered by the Society on a case by case basis.

e) In respect of Ch 5, [8.1.1] of the Tasneef "Rules for loading and unloading arrangements and for other lifting appli-ances on board ships", particular attention is to be paid for protection of deck openings in the main deck of air-craft carriers, helicopter carriers and supply ships.

2.6 Lifts for persons

2.6.1

Lifts for persons are to be certified according to the Tasneef "Rules for the certification of lifts and escalators for passen-gers and crew members".

2.7 RAS stations

2.7.1

RAS stations are to be certified according to the Tasneef "Rules for loading and unloading arrangements and for other lifting appliances on board ships", as applicable.

3 Other recognised standards

3.1 General

3.1.1

The compliance with recognised standards (e.g. API-2C, EN 13852-2:2005, NAV 70-0000-0001-14-00B0000) other than those indicated in [2.1] may be accepted by the Soci-ety on a case by case basis. In any case, plan approval and testing of materials, loose gears and lifting appliances are to be carried out by the Society.

SECTION 5 ITALIAN NAVY STANDARD (MMI-STD)

1 General

1.1 General

1.1.1 Applicability

This Section provides the criteria for the assignment of the additional class notation **MMI-STD** in accordance with Pt A, Ch 1, Sec 2, [7.6.7], to ships complying with the enhanced technical standards adopted by the Italian Navy.

2 Subdivision arrangement

2.1 Watertight deck

2.1.1

The requirements of Pt B, Ch 1, Sec 2, [6.4.1] and Pt B, Ch 2, Sec 1, Tab 3 are to be applied also to **auxiliary ships**.

2.2 Watertight doors

2.2.1

Notwithstanding the requirements of Pt B, Ch 2, Sec 1, Tab 3, on **auxiliary ships** a limited quantity of watertight located doors below the watertight deck may be accepted if necessary for the optimisation of logistic flows; the number and location of such doors is to be agreed with the Naval Authority.

2.2.2

In lieu of the requirements of Pt B, Ch 2, Sec 1, [6.2.14], the central operating console at the navigation bridge and at the damage control station(s) is to have a "master mode" switch with three modes of control:

- a "local control" mode which is to allow any door to be locally opened and locally closed after use without automatic closure, and
- a "doors closed" mode which is to automatically close any door that is open. The "doors closed" mode is to permit doors to be opened locally and is to automatically reclose the doors upon release of the local control mechanism.
- a "doors locked" mode which is to automatically close any door that is open. The "doors locked" mode is not to permit doors to be opened locally.

The "master mode" switch is to normally be in the "local control" mode.

The "doors closed" mode is to only be used in an emergency or for testing purposes.

The "doors locked" mode may be used in extreme emergency conditions at discretion of the Master or for testing purposes. The activation of "doors locked" mode is to give a visual and audible alarm which is not to be overridden.

Special consideration is to be given to the reliability of the "master mode" switch.

3 Stability

3.1 Ship mass evolution

3.1.1

In lieu of the requirements of Pt B, Ch 3, Sec 2, [2.1.4], unless otherwise stated by the Naval Authority, for auxiliary ships the stability has to be assessed taking into account a total mass evolution equal to:

- 4,0 % of growth in light ship displacement in respect of the light ship displacement at delivery;
- 5,0 % of rise of the position of the centre of gravity in respect of the height of centre of gravity in the light ship at delivery.

4 Machinery and Systems

4.1 Ambient conditions

4.1.1

In lieu of the requirements of Pt C, Ch 1, Sec 1, [2.5.1] and Tab 2, machinery and systems covered by the Rules are to be designed to operate properly under the ambient conditions specified in Tab 1, unless otherwise specified in the Rules.

4.2 Gearing

4.2.1

Notwithstanding the provisions of Pt C, Ch 1, Sec 6, [1.1.1], the requirements of Pt C, Ch 1, Sec 6 are to be applied also to **second line** and **auxiliary ships**.

4.3 Compressed breathable air systems

4.3.1

In addition to the requirements of Pt C, Ch 1, Sec 10, [14.9], the following requirements are to be complied with:

a) The electric driven compressor capacity is not to exceed 600 l/min;

b) The filling/refilling station is to be provided with high pressure storage containers (pressure bottles of 50 l capacity at rated pressure) with an aggregate capacity of at least 150 litres;

c) The air filtering system is to provide air quality in accordance with NATO ADIVP-1(A)/MDIVP-1(A) "Multinational Guide to Diving Operations".

d) Each filling/refilling station is to be capable of simultaneous recharging of:

- For **front line ships**: 8 breathing apparatus with capacity of 7 litres at 30 Mpa in 15 minutes;
- For **second line** and **auxiliary ships**: 4 breathing apparatus with capacity of 7 litres at 30 Mpa in 15 minutes.

In addition, the system is to be capable of refilling divers equipment at 20 Mpa.

e) After the compressor and before the filtering unit, the system is to be connected by means of adequate pressure reduction units to the ship's medium pressure system;

f) At least two portable diesel engine driven compressors are to be provided having the following characteristics:

- Capacity not less than 200 l/min at 30 Mpa.
- Filtration system in accordance with NATO ADIVP-1(A)/MDIVP-1(A)
- Dimensions and weight adequate for the easy transportation on the damage control deck and on main deck; in general, weight is not to exceed 160 kg.
- Wheeled carrying trolley

The portable diesel engine driven compressors are to be capable of connection with the fixed filling/refilling station.

5 Electrical installations

5.1 Degrees of protection of the enclosures

5.1.1

In lieu of the provision of Pt C, Ch 2, Sec 3, Tab 1, the minimum required degree of protection for electrical equipment, in relation to the place of installation, is to be determined in accordance with Tab 2.

Table 1 : Ambient conditions

AIR TEMPERATURE	
Location, arrangement	Temperature range (°C)
In enclosed spaces	between 0 and +55 (2)
On machinery components In spaces subject to higher or lower temperatures	According to specific local conditions
On exposed decks	between -25 and +45 (1)
WATER TEMPERATURE	
Coolant	Temperature (°C)
Sea water or, if applicable, sea water at charge air coolant inlet	up to +32

(1) Electronic appliances are to be designed for an air temperature up to 55°C (for electronic appliances see also Pt C, Chapter 3).
(2) Different temperatures may be accepted by the Society in the case of ships intended for restricted service.
(3) For NBC conditions the limits specified by the owner and Ch 1, Sec 9, [2.4.3] apply.

(1) Electronic appliances are to be designed for an air temperature up to 55°C (for electronic appliances see also Pt C, Chapter 3).
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6 Fire protection

6.1 Fire fighting

6.1.1 Low expansion foam system

A low expansion foam system complying with Pt C, Ch 4, Sec 13 is to be provided to extinguishing fire in all machinery space bilges.

6.2 Additional fire safety measures for flight-deck

6.2.1 General *(1/1/2017)*

In addition to the requirements of the additional class notation **HELICOPTER** the helicopter flight-deck shall be provided with the following fire-fighting appliances:

a) A twin media flight-deck system.

b) Autonomous mobile twin media system.

6.2.2 Twin media flight-deck system *(1/1/2017)*

The two media shall be dry chemical powder, and foam solution (that is water plus foam concentrate).

The two media shall be stored in pressure vessels which shall be pressurized by pressure air in dedicated pressurized bottles.

In addition the system shall be provided with control, fixed media pressurizing piping and fixed media delivering pipes to monitors and/or hand hose lines.

The two media shall be simultaneously delivered by in pairs monitors and/or by the in pairs nozzles of relevant hand hoses.

The system shall be capable to delivery the two media on any part of an helicopter, on flight-deck which has caught fire.

Except for the parking area for helicopter on flight-deck, the system may be provided with only hose line nozzles (foam line and powder line). The hand hose line shall not exceed 33 metres. The nozzles throw is to be assumed as documented by the manufacturer.

Any part of flight-deck parking area for helicopter shall be covered by the throw of twin media in pairs monitors. The throw of monitors is to be assumed as documented by the manufacturer.

The discharge rate of a:

- powder hose line nozzle shall be not less than 3,5 kg/s;
- foam hose line nozzle shall be not less than 5 l/s;
- powder monitor shall be respectively not less than 10, 25 and 45 kilograms per second for the maximum coverage distance of 10, 30 and 40 meters;
- foam monitor shall be not less 20 l/s.

The quantity of chemical powder and foam solution in the system containers shall not be less than the quantity required for 45 seconds discharge time for all monitors and/or nozzle hoses attached to each powder and to each foam solution unit. 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.

The flight-deck 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 aircraft and helicopter operations.

In pairs nozzles shall have features by one man operation.

Monitors shall have features for manual and remote control laying as well as for media discharge operations.

Table 2 : Minimum required degrees of protection

Example of location	Switchboard Control gear Motor starters	Generators	Motors	Transformers	Luminaires	Heating appliances	Cooking appliances	Socket outiets	Accessories (e.g. switches, connection boxes)
Dry accommodation spaces Dry control rooms	I P 21	X **(1)**	I P 21	I P 20	I P 20	I P 20	X	I P 21	I P 21
Control rooms, wheelhouse, radio room	I P 22	X	I P 22	I P 22	I P 22	I P 22	X	I P 22	I P 22
Engine and boiler rooms above floor	I P 44	I P 44	I P 23 **(5)**	I P 23 **(5)**	I P 34	I P 44	X	I P 44	I P 44
Steering gear rooms	I P 44	I P 44	I P 23 **(5)**	I P 23 **(5)**	I P 34	I P 44	X	I P 44	I P 44
Emergency machinery rooms	I P 44 **(3)**	I P 44	I P 23 **(5)**	I P 23 **(5)**	I P 34	I P 44	X	I P 44	I P 44
General store rooms	I P 44	X	I P 23 **(5)**	I P 23 **(5)**	I P 34	I P 44	X	I P 44	I P 44
Pantries	I P 44	X	I P 23 **(5)**	I P 23 **(5)**	I P 34	I P 44	I P 22	I P 44	I P 44
Provision rooms	I P 44	X	I P 23 **(5)**	I P 23 **(5)**	I P 34	I P 44	X	I P 44	I P 44
Ventilation ducts	X	X	I P 44	X	X	X	X	X	X
Bathrooms and/or showers	X	X	X	X	I P 55	IP 55	X	I P 55	I P 55
Engine and boiler rooms below floor	X	X	I P 44	X	I P 55	X	X	X	X
Closed fuel oil separator rooms **(4)**	I P 44	X	I P 44	I P 44	I P 55	I P 55	X	X	I P 55
Closed lubricating oil separator rooms **(4)**	I P 44	X	I P 44	I P 44	I P 55	I P 55	X	X	I P 55
Ballast pump rooms	I P 44	X	I P 44 **(2)**	I P 44 **(2)**	I P 55	I P 55	X	I P 55	I P 55
Refrigerated rooms	X	X	I P 44	X	I P 55	I P 55	X	I P 55	I P 55
Galleys and laundries	I P 44	X	I P 44	I P 44	I P 55	I P 55	I P 44	I P 55	I P 55
Public bathrooms and shower	X	X	I P 44	I P 44	I P 55	I P 55	X	I P 55	I P 55
Shaft or pipe tunnels in double bottom	I P 55	X	I P 55	I P 55	I P 55	I P55	X	I P 56	I P 56
Holds for general cargo	X	X	I P 55	X	I P 55	I P55	X	I P 56	I P 56
Ventilation trunks	X	X	I P 55	X	X	X	X	X	X
Open decks	I P 56	X	I P 56	X	I P 56	I P56	X	I P 56	I P 56

(1) The symbol "X" denotes equipment which it is not advised to install.
(2) Electric motors and starting transformers for lateral thrust propellers located in spaces similar to ballast pump rooms may have degree of protection IP22.
(3) IP21 may be accepted where Emergency Switchboard is adequately protected against danger of liquid damage.
(4) When the fuel or lubrificating oil are heated within 15°C of their of lash point or above, the use of certified safe type electrical equipment is to be considered.
(5) Terminal box is to be IP44.

SECTION 6 ENHANCED DAMAGE STABILITY (EDMS)

1 General

1.1 Scope

1.1.1 *(1/1/2017)*

The additional class notation **EDMS** is assigned to a ship in order to certify that measures are taken to improve buoyancy and stability characteristics in way to withstand a damage to the hull, caused by a combat shot or an event at sea, wider than those required in Pt B, Ch 3, Sec 3 [2.4.2].

1.2 Field of application

1.2.1 *(1/1/2017)*

The additional class notation **EDMS** is assigned to ships, irrespectively to their service, complying with the requirements of this Section. The notation is completed by a number **N**, which represents the number of main compartments considered flooded, or by the wording **VULN** when, in agreement with the Naval Authority, the damage scenario is obtained from a vulnerability analysis, in accordance with Pt A, Ch 1, Sec 2, [6.6.8].

1.3 Condition for the assignment

1.3.1 *(1/1/2017)*

The assignment of the notation implies that a stability analysis is carried out in order to ascertain that, after any postulated damage, the ship meets the survival standard for the loading conditions mentioned in Pt B, Ch 1, Sec 2 [5.2], [5.3] and [5.4], allowing for the possible evolution of mass during the ship life as given in Pt B, Ch 3, Sec 2 [2.1.4].

1.4 Documentation to be submitted

1.4.1 *(1/1/2017)*

A damage stability booklet shall be submitted for approval.

2 Damage and criteria

2.1 Damage

2.1.1 *(1/1/2017)*

The damage to be taken into account is a continuous breach in the hull of the ship as described in Pt B, Ch 3, Sec 3 [2.4.2], considering that its longitudinal extension causes the flooding of N main adjacent compartments as defined in Pt B, Ch 1, Sec 2 [6.7]. In case the notation is assigned considering a vulnerability analysis, the number of adjacent compartments flooded shall vary along the ship according to the analysis

2.2 Criteria

2.2.1 *(1/1/2017)*

Criteria and calculation assumptions contained in paragraphs from [2.4.3] to [2.4.12] of Pt B, Ch 3, Sec 3 apply for the assignment of this additional class notation.

SECTION 7 SEA AND AIR POLLUTION PREVENTION (GREEN PLUS MIL)

1 General

1.1 Application

1.1.1 *(1/1/2017)*

The additional class notation **GREEN PLUS MIL** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.6.8], to ship designed and provided with systems, components and procedural means to control and prevent the emission of polluting substances into the sea, the air and, more in general, the environment, in accordance with the requirements of [6.1].

A Certificate of Compliance may be issued to ships not classed with the Society, fulfilling the requirements of this section.

2 Definitions

2.1

2.1.1 *(1/1/2017)*

Definitions are those given in:

- International Convention for the Prevention of Pollution from Ships (MARPOL Convention)
- International Maritime Dangerous Goods Code (IMDG Code)

2.1.2 *(1/1/2017)*

- Cold ironing: process of providing shore-side electrical power by means of a high-voltage shore connection system designed to supply the ship when operational and lying in port while its main and auxiliary engines are turned off.
- Gas to liquid fuels (GTL): fuels obtained according a refinery process which converts natural gas or other gaseous hydrocarbons into longer-chain hydrocarbons
- Global Warming Potential (GWP): potential global warming effect of a gas compared with CO2 on a time horizon of 100 years
- Greenhouse gas (GHG): gaseous constituent of the atmosphere, both natural and anthropogenic, that adsorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the earth's surface, the atmosphere and the clouds
- Grey water: drainage from dishwater, shower, laundry, bath and washbasin drains. It does not include drainage from toilets, urinals, hospitals, and animal spaces, as defined in regulation 1.3 of MARPOL Annex IV (sewage), and it does not include drainage from cargo spaces.
- Liquefied Natural Gas (LNG): natural gas (primarily methane, CH4) converted to liquid form for ease of storage or transport.
- Low energy consumption lights: lights other than incandescent light bulbs, halogen lamps and those having similar lum/W ratio, recognized by appropriate national or international standards.
- Second generation bio-fuels: fuels produced sustainably by using biomass comprised of the residual non-food parts of current crops, such as stems, leaves and husks that are left behind once the food crop has been extracted, as well as other crops that are not used for food purposes, such as switch grass and cereals that bear little grain, and also industry waste such as wood chips, skins and pulp from fruit pressing etc., whereby the complete cycle from production to consumption, allows to obtain, with equal total power generated, a reduction in CO_2 emissions of over 85% compared to fossil fuels.
- Ship Environmental Manager: officer in service on board, in charge of the management and control of the procedures and activities relevant to the requirements of this Section
- VGP: Vessel General Permit for discharges incidental to the normal operation of vessels.

3 Documents to be submitted

3.1

3.1.1 *(1/1/2017)*

The general list of plans and documents to be submitted is given in Tab 1. Plans and documents relating to systems, components and procedural means not adopted to build the ship's environment index need not be submitted. The Society reserves the right to request the submission of additional documents in the case of non-conventional design or if it is deemed necessary for the evaluation of the systems and components.

Table 1 : Documents to be submitted *(1/1/2017)*

No.	A/I **(1)**	Document
1	I	Ship Environmental Management Plan
2	A	Shipboard Oil Pollution Emergency Plan
3	I	International Oil Pollution Prevention Certificate
4	A	Drawings with indication of capacities of oil, fuel, sludge and lubricating oil tanks, distances from the base line and shell plates, relevant piping and means of disposales
5	A	Drawings with indication of oil fuel tank capacity, localisation, piping, valves, calculation based on accidental oil fuel outflow performance standard (if applied)
6	A	Oil filtering equipment design and type approval certificate
7	I	Specification of flanges for discharge connections (bilge, sludge and sewage)
8	A	Tank general arrangement plan showing the bilge tanks, their capacities and alarms
9	I	General arrangement plan with indication of the zone intended for the stowage of packaged harmful substances in relation to the other zones of the ship
10	I	Data sheet and test report of biodegradable and low aquatic toxicity lube oil
11	I	Stern tube bearings description
12	I	Description of manoeuvring systems
13	A	Drawing with indication of capacity, dimensions, localization and protective location of segregated ballast tanks
14	A	Pump room bottom protection description and dimensions
15	A	Damage calculations
16	A	Drawing with indication of capacity and localization of slop tanks
17	A	Operational manual for oil discharge monitoring and control system
18	A	Oil/ water interface detector drawing and description
19	I	International Sewage Pollution Prevention Certificate
20	I	Type approval certificate of for sewage treatment plan
21	A	Drawings with indication of the treated sewage holding tanks, their capacities and alarms
22	I	Record books (oil, sewage, garbage, grey, ozone depleting substances)
23	I	Grey water treatment system certification
24	I	Drawings with indication of the grey water holding tanks, their capacities and alarms
25	A	Garbage management plan
26	A	Ballast water management plan
27	I	Ballast water treatment type approval certificate
28	A	Anti-fouling system specification
29	I	List of ozone depleting substances present on board
30	I	Data sheets with list of refrigerants used in the different refrigeration systems, their quantities and their GWP and ODP
31	I	Data sheets with the list of fixed fire-fighting means used, their quantities and GWP values
32	I	Power and description of alternative system for energy and propulsion production
33	I	Description of tool to monitor and record fuels
34	I	Energy saving manual
35	A	Fuel consumption study and solution
36	I	Hull transom design study
(1) A = to be submitted for approval; I = to be submitted for information		

No.	A/I **(1)**	Document
37	I	Calculation relevant to high performing propellers
38	I	NOx technical file and Engine International Air Pollution Prevention Certificate
39	A	Exhaust gas treatment system plan, characteristics and efficiency and type approval certificate
40	I	Average S of the fuels used
41	I	Emission monitoring and recording description
42	A	Vapour emission collection system
43	I	Noise assessment and measurements
44	A	Inventory of hazardous materials
(1) A = to be submitted for approval; I = to be submitted for information		

4 Requisites

4.1 General requirements

4.1.1 *(1/1/2017)*

A Ship Environmental Manager is to be appointed and present on board.

4.1.2 *(1/1/2017)*

An Environmental Management Plan, specific to the ship, is to be made available on board. The Plan is to contain at least the procedures listed in App 1, [3].

4.1.3 *(1/1/2017)*

A Shipboard Oil Pollution Emergency Plan is to be present on board. The Plan is to comply with MARPOL, Annex I, regulation 37, and it is to be prepared based on IMO Guidelines (Resolution MEPC 54(32) as amended by Resolution MEPC.86(44)).

4.1.4 *(1/1/2017)*

Auxiliary supply ships of 5,000 tons deadweight or more are to have prompt access to computerized shore-based damage stability and residual structural strength calculation programs.

4.1.5 *(1/1/2017)*

Adequate training on environmental issues is to be planned, carried out and documented for all the persons on board having influence on the environmental behaviour of the ship.

4.2 Additional systems, components and procedural means

4.2.1 *(1/1/2017)*

The list of additional systems, components and procedural means which can be considered for the assignment of the notation and the values to be used for the calculation of the relevant environmental index, as indicated in [5], are given in the third and fourth column of Tab 2, respectively. Each item is detailed in the App 1.

Table 2 : Additional systems, components and procedural means *(1/1/2017)*

No.	Pollution source	Item	Environ-mental index	References (App 1)
Prevention of sea pollution				
1	Oil	International Oil Pollution Prevention Certificate	16 **(1)**	[1.1.1]
		Oil Record book	2	[1.1.2]
		Tank(s) for oil residues	1 **(1)**	[1.1.3]
		Oil fuel tank protection by means of tank boundary distance from the ship side and bottom	6 **(1)**	[1.1.5]
		Oil fuel tank protection by means of outflow calculation	4 **(1)**	[1.1.5]
		Bilge Water Treatment (15 ppm)	1 **(1)**	[1.1.6]
		Bilge Water Treatment (15 ppm with alarm and automatic stop)	2 **(2)**	[1.1.7]
		Bilge Water Treatment (5 ppm with alarm and automatic stop)	4 **(2)**	[1.1.8]
		Bilge Water Treatment (5 ppm with alarm, automatic stop and recorder)	6 **(2)**	[1.1.9]
		Flanges for discharge connection	1 **(1)**	[1.1.10]
		Bilge oil tank	2	[1.1.11]
		Retention on board	8	[1.1.12]
		Restrictions in the use of ship's fuel tanks for ballast	1	[1.1.13]
		Lubricating oil and sludge tank protection by means of tank boundary distance from the ship side and bottom	6 **(3) (1)**	[1.1.14]
		Lubricating oil and sludge tank protection by means of outflow calculation	4 **(3) (1)**	[1.1.15]
		Restriction in the carriage of oil in forepeak tanks	1 **(1)**	[1.1.16]
		Oil tank overflow	1	[1.1.17]
		Gutters	1	[1.1.18]
		Dry bilge concept	2	[1.1.19]
		Sludge oil collection and handling facilities	2	[1.1.20]
		Water-lubricated stern tube bearings	4	[1.1.21]
		Magnetic coupling on oil pumps	5	[1.1.22]
		Biodegradable and low aquatic toxicity lube oil	5	[1.1.23]
		Restriction in the use of hydraulic plants	7	[1.1.24]

(1) to **(6)** With reference to the items where a note (1) to (9) appears, only one corresponding environmental index is assignable.
(7) applicable only to ships intended to operate at a fixed location.
(8) to be weighted.

No.	Pollution source	Item	Environ-mental index	References (App 1)
2	Oil cargo (Auxiliary supply ships)	Segregated ballast tank	3	[1.2.1]
		Protective location of segregated ballast	4 **(4)**	[1.2.2]
		Double hull and bottom	5 **(4)**	[1.2.3]
		Pump room bottom protection	2	[1.2.4]
		Collision or stranding protection	5	[1.2.5]
		Intact stability	4	[1.2.6]
		Subdivision and damage stability	5	[1.2.7]
		Slop tanks	3	[1.2.8]
		Discharge system	3	[1.2.9]
		Oil discharge monitoring and control system	3	[1.2.10]
3	Sewage	International Sewage Pollution Prevention Certificate	4 **(5)**	[1.3.1]
		Sewage treatment plant of type approved (Resolution MEPC.2(VI))	2 **(5)**	[1.3.2]
		Sewage treatment plant of type approved (Resolution MEPC 227(64))	4 **(5)**	[1.3.3]
		Sewage treatment plant: effluent quality as per 33 CFR Part 159 Subpart E	6	[1.3.4]
		Holding tank	3	[1.3.5]
		Flanges for discharge connection	1 **(5)**	[1.3.6]
		Sewage discharge record book	2	[1.3.7]
4	Grey water	Grey water and sewage treatment system	2 **(6)**	[1.4.1]
		Grey water treatment system (VGP 2013)	4 **(6)**	[1.4.2]
		Holding tank	3	[1.4.3]
		Grey water record book	2	[1.4.4]
		Placards	1	[1.5.1]
5	Garbage	Garbage Management Plan	2	[1.5.2]
		Garbage record keeping	2	[1.5.3]
		Ballast water exchange	5	[1.6.1]
6	Other sources	Ballast water treatment	7	[1.6.2]
		Control of Harmful Anti-fouling Systems	5	[1.6.3]
		Marine growth prevention systems	5	[1.6.4]
		Collection of spillage/ leakage of environmental hazardous substances	3	[1.6.5]
Prevention of air pollution				
7	Ozone-depleting substances	No hydro-chlorofluorocarbons	2	[2.1.2]
		Ozone depleting substances record book	2	[2.1.3]
		Restrictions in the use of GWP substances	10 **(8)**	[2.1.4]
		Non fossil fuels	30 **(8)**	[2.2.1]

(1) to **(6)** With reference to the items where a note (1) to (9) appears, only one corresponding environmental index is assignable.
(7) applicable only to ships intended to operate at a fixed location.
(8) to be weighted.

No.	Pollution source	Item	Environ-mental index	References (App 1)
8	Green house gases and pollutants	Second generation of bio-fuels	20 **(8)**	[2.2.2]
		Cold ironing	5	[2.2.3]
		Tool to manage handling and consumption of fuels	2	[2.2.4]
		Computerized system to monitor fuel consumption	3	[2.2.5]
		Support tool to assist the Master in keeping most efficient sailing draft and trim	10	[2.2.6]
		Energy saving and energy conservation	5	[2.2.7]
		Fuel Consumption Decision Support Solution	10	[2.2.8]
		Optimization of Air Conditioning (AC) plant	5	[2.2.9]
		Low energy consumption lights	5	[2.2.10]
		Hull transom design	3	[2.2.11]
		Stabilizer openings	3	[2.2.12]
		Silicone-based antifouling paint	10	[2.2.13]
		Fluoropolymer antifouling paint	15	[2.2.14]
		Fins on propeller boss cups	3	[2.2.15]
		High-performing propellers	5	[2.2.16]
		Installation of high efficiency (IE2) and premium efficiency (IE3) motors	3 **(8)**	[2.2.17]
9	NOx	Tier 1	5	[2.3.1]
		Tier 2	10	[2.3.2]
		Tier 3	15	[2.3.3]
		Gas to liquids (GTL) fuels	15 **(8)**	[2.3.4]
		Fuel treatment	10 **(8)**	[2.3.5]
		Dual-fuel engines running with LNG	15	[2.3.6]
		Exhaust gas treatment	20	[2.3.7]
		NOx emissions monitoring and recording	3	[2.3.8]
10	SOx	SOx limits (global 3,5% and 0,1 % in SECA)	5 **(7)**	[2.4.1]
		SOx limits (global 1.0% and 0,1 % in SECA)	10 **(7)**	[2.4.2]
		SOx limits (0,1%)	25 **(7)**	[2.4.3]
		Gas to liquids (GTL) fuels	15 **(8)**	[2.4.4]
		Blending fossil fuel with second-generation bio-fuels	10 **(8)**	[2.4.5]
		Dual-fuel engines running with LNG	10	[2.4.6]
		Exhaust gas treatment	20	[2.4.7]
		SOx emissions monitoring and recording	3	[2.4.8]
		Vapour emission control system	10	[2.5.1]

(1) to **(6)** With reference to the items where a note (1) to (9) appears, only one corresponding environmental index is assignable.
(7) applicable only to ships intended to operate at a fixed location.
(8) to be weighted.

No.	Pollution source	Item	Environ-mental index	References (App 1)
11	Volatile Organic Compounds (Auxiliary supply ships)	Gas to liquids (GTL) fuels	15 **(8)**	[2.6.1]
12	Particulates	Fuel treatment	10 **(8)**	[2.6.2]
		Prime movers modifications	15 **(8)**	[2.6.3]
		Dual-fuel engines running with LNG	15	[2.6.4]
		Exhaust gas treatment	20	[2.6.5]
13	CO_2	Gas to liquids (GTL) fuels	15 **(8)**	[2.7.1]
		Blending fossil fuel with second-generation bio-fuels	10 **(8)**	[2.7.2]
		Dual-fuel engines running with LNG	5	[2.7.3]
		CO_2 monitoring and recording	3	[2.7.4]
14	Noise	Noise level assessment and implementation of the noise mitigation measures	10	[2.8.1]
15	Ship at scrap	Inventory of hazardous materials	5	[2.10.1]

(1) to **(6)** With reference to the items where a note (1) to (9) appears, only one corresponding environmental index is assignable.
(7) applicable only to ships intended to operate at a fixed location.
(8) to be weighted.

5 Environmental index

5.1 Index calculation

5.1.1 *(1/1/2017)*

The environmental index is obtained by adding up the values of the contributions for each additional system, component and procedural means (items) the ship is equipped with, according to Tab 2.

6 Assignment criteria

6.1 Ships other than Auxiliary Supply Ships

6.1.1 *(1/1/2017)*

The additional class notation **GREEN PLUS MIL** is assigned to ships (other than Auxiliary Supply Ships):

a) complying with [4.1] and [4.2]

b) having additional systems, components and procedural means selected from items of Tab 2, pertaining to at least nine different pollution sources (as listed in the second column of Tab 2)

c) having an environmental index calculated in accordance with [5.1] greater than or equal to 100.

6.2 Auxiliary Supply Ships

6.2.1 *(1/1/2017)*

The additional class notation **GREEN PLUS MIL** is assigned to Auxiliary Supply Ships:

a) complying with [4.1] and [4.2]

b) having additional systems, components and procedural means selected from items of Tab 2, pertaining to at least twelve different pollution sources (as listed in the second column of Tab 2)

c) having an environmental index calculated in accordance with [5.1] greater than or equal to 130.

7 Novel features

7.1 General

7.1.1 *(1/1/2017)*

For the assignment of the notation the Society may consider systems, components and procedural means not listed in Tab 2 based on novel principles and features on the basis of tests, calculations or other supporting information.

7.2 Examples

7.2.1 *(1/1/2017)*

Equipment to maximize the recovery of waste heat, electrical propulsion systems designed to have the maximum efficiency at the different operational conditions of the ship and any other fuel saving techniques may be considered by the Society, on the basis of comparative studies to be submitted, for the calculation of the ship's environmental index.

8 Systems and components

8.1 Systems and components certification

8.1.1 *(1/1/2017)*

When systems and components are recognized as being capable of improving the ship's environmental behavior, the Society may issue, upon request of the applicant (manufacturer or responsible vendor) a certificate stating the environmental properties of the system or component.

The certificate may be issued in accordance with applicable national or international standards or, in the absence of such standards, on the basis of the manufacturer's standards or specifications.

The compliance to the reference document is ascertained by means of:

- execution of tests; or
- review of test documentation; or
- evidence of positive results during in-service operation; or
- any combination of the above criteria.

APPENDIX 1 BASIC AND ADDITIONAL SYSTEMS, COMPONENTS AND PROCEDURAL MEANS TO EVALUATE THE SHIP'S ENVIRONMENTAL INDEX AS PER THE GREEN PLUS MIL NOTATION

1 Prevention of sea pollution

1.1 Oil

1.1.1 International Oil Pollution Prevention Certificate *(1/1/2017)*

A certificate is to be issued under the provisions of the MARPOL Convention, Annex I, by the society. The certificate is to be renewed within the time described by MARPOL.

In case the certificate has been issued with some exceptions, the index is to be weighted accordingly.

1.1.2 Oil Record Book *(1/1/2017)*

A Oil Record Book, complied with the form in MARPOL Convention, Annex I, appendix III, is to be present on board and fill in in accordance with the MARPOL Convention, Annex I regulations.

1.1.3 Tank(s) for oil residues *(1/1/2017)*

A tank or tanks for oil residues (sludge) is to be provided on board according to the criteria of MARPOL Convention, Annex I, regulation 12.

1.1.4 Oil fuel tank protection by means of tank boundary distance from the ship side and bottom *(1/1/2017)*

An oil fuel tanks protection is to be guaranteed in compliance with MARPOL Convention, Annex I, regulation 12A, including prescriptions about piping and valves close to ship's bottom and side.

1.1.5 Oil fuel tank protection by means of outflow calculation *(1/1/2017)*

The protection of the oil fuel tank is to be achieved applying the criteria of MARPOL Annex I Reg. 12A based upon outflow calculation.

1.1.6 Bilge Water Treatment (15 ppm) *(1/1/2017)*

The oil filtering equipment is to be in compliance with MARPOL Convention, Annex I, regulation 14 (except regulation 14.7).

1.1.7 Bilge Water Treatment (15 ppm with alarm and automatic stop) *(1/1/2017)*

The oil filtering equipment is to grant maximum oil content in the effluent up to 15 ppm, be provided with an oil content meter and with a 15 ppm alarm in a manned position, combined with automatic stopping device.

The effluent from the 15 ppm filtering equipment is to be capable of being recirculated to the bilge water holding tank (see [1.1.7]).

1.1.8 Bilge Water Treatment (5 ppm with alarm and automatic stop) *(1/1/2017)*

The oil filtering equipment is to grant maximum oil content in the effluent up to 5 ppm, be provided with an oil content meter and with a 5 ppm alarm in a manned position, combined with automatic stopping device.

If additional equipment is installed to ensure the above performance, it is to be approved by the Society.

If the performance of 5 ppm is ensured by a system type approved according to applicable MARPOL regulations, such performance is to be verified by the Society.

The effluent from the 5 ppm filtering equipment is to be capable of being recirculated to the bilge water holding tank, see [1.1.7].

1.1.9 Bilge Water Treatment (5 ppm with alarm, automatic stop and recorder) *(1/1/2017)*

In addition to [1.1.5] the system is to be provided with:

a) a monitoring and control system, supervising the overboard discharge of the treated bilge water and including a fuel oil grease monitor, a flow meter, control means, valves and fittings, capable of:
   1) providing a fail-safe system for discharging treated bilge water overboard including immediate shutdown of Bilge Water Separator in the event of
      - high oil content
      - insufficient flow of sampling water through the Oil monitor
      - the rinse/sampling valves (inlet and outlet) of the Oil monitor are not closed
   2) measuring the flow of the water and the oil content value
   3) giving alarm signals
   4) controlling the position of the overboard discharge three-way valve

   The open command of remote controlled overboard discharge valve is to be authorised from the bridge and indication of the status of manually operated overboard discharge valves is to be available on the bridge.

b) a recorder capable of recording
   1) ship's time
   2) run stop time of bilge water separator
   3) all the data from the monitoring and control system as described in a).

1.1.10 Flanges for discharge connection *(1/1/2017)*

The two discharge pipelines for residues from machinery bilges and from oil residue (sludge) tanks are to be fitted with flange in accordance with the standard in MARPOL Convention, Annex I, regulation 13.

1.1.11 Bilge oil tank *(1/1/2017)*

All machinery space bilges are to be drained into a holding tank for pre-separation upstream of the oil separation and filtering equipment.

Alternative installations may be considered on a case-by-case basis.

The volume V of the holding tank, in m^3, is to be at least:

$V = 1 + 5,5\ P \cdot 10^{-4}$

where P is the power of the propulsion engine plant, in kW.

In any event, it is not required that the volume V is greater than 15 m^3.

Taking into account the ship service, navigation and installed power, a smaller volume V may be accepted on a case-by-case basis.

The tank is to be so arranged as to allow periodical removal of sediments.

For ships operating with fuel oil having a mass density at 15°C greater than 0,94 kg/dm^3 and viscosity at 50°C greater than 110 centistokes, this tank is to be provided with heating arrangements.

The holding tank is to be connected to the standard discharge connection referred to in regulation 13, Annex I to MARPOL 73/78 as amended.

No interconnections between the sludge tank discharge piping and bilge-water piping is to be present, other than possible common piping leading to the standard discharge connection referred to in regulation 13, Annex I to MARPOL 73/78 as amended.

A high level alarm is to be given in a manned position.

1.1.12 Retention on board *(1/1/2017)*

An oil bilge water holding tank is to be arranged to collect all machinery space oily bilge waters for their subsequent discharge ashore to dedicated reception facilities through the standard discharge connection referred to in regulation 13, Annex I to MARPOL 73/78 as amended, or any other approved means of disposal. The retention tank(s) is (are) to be separated and independent from the sludge tank.

The minimum total capacity of the holding tank(s) is (are) to be evaluated on the basis of the type of ship and its machinery considering 30 days of voyage duration.

The tank is to be so arranged as to allow periodical removal of sediments.

For ships operating with fuel oil having a mass density at 15°C greater than 0,94 kg/dm^3 and viscosity at 50°C greater than 110 centistokes, this tank is to be provided with heating arrangements.

A high level alarm is to be given in a manned position.

1.1.13 Restrictions in the use of ship's tanks for ballast *(1/1/2017)*

The use of tanks intended for fuel oil as ballast tanks is not allowed, irrespective of their volume.

1.1.14 Lubricating oil and sludge tank protection by means of tank boundary distance from the ship side and bottom *(1/1/2017)*

The protection of the tanks is to be achieved applying the criteria of MARPOL, Annex I, Regulation 12A based upon the distance of the fuel oil tanks boundary from the ship side and bottom.

The requirement is not applicable to the double bottom for lubricating oil located under the main engine.

1.1.15 Lubricating oil and sludge tank protection by means of outflow calculation *(1/1/2017)*

The protection of the tanks is to be achieved applying the criteria of MARPOL Annex I Regulation 12A based upon outflow calculation.

The requirement is not applicable to the double bottom for lubricating oil located under the main engine.

1.1.16 Restriction in the carriage of oil in forepeak tanks *(1/1/2017)*

Forepeak tank and tank forward of the collision bulkhead are not to be used for the carriage of petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products, including the substances listed in MARPOL, Annex I, appendix I.

1.1.17 Oil tank overflow *(1/1/2017)*

a) All fuel oil and lubricating oil tanks of capacity greater than 10 m^3 are to be fitted with an overflow system and a high level alarm.

   Acceptable alternatives are:
   - an overflow system and a flow alarm in the overflow main
   - no overflow system and two high level alarms (for instance at 90% and 95% of filling).

b) The alarm signals are to be given in a suitable position from which bunkering or transfer operations are controlled.

1.1.18 Gutters *(1/1/2017)*

On the weather and/or superstructure decks each fuel or lubricating oil tank vent, overflow and fill pipe connection is to be fitted with a fixed 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.

1.1.19 Dry bilge concept *(1/1/2017)*

An adequate number of tanks of 1 m^3 minimum each is to be installed to collect drainage water from one or more equipment (e.g. diesel engine scavenging air coolers, potable water analyzers, low temperature heat exchangers) within the same compartment which have drainage water with similar characteristics. Such tanks have the function to drastically reduce water drainage to bilge spaces and so reduce the oily water, emulsified bilge water and other contaminated water collecting in bilge wells.

Each tank is to be equipped with automatic transfer means, level indicator for local control and high level alarm given in a manned position.

1.1.20 Sludge oil collection and handling facilities *(1/1/2017)*

An adequate number of tanks of 100 l approximate capacity each is to be installed to collect oily liquids from drains, vents, seals and glands of all equipment in machinery spaces and bunker stations connected to a fuel oil and lubricating oil system.

The tanks are to be installed outside the double bottom. Drain lines must not pass through watertight bulkheads or tank tops.

The tanks are to be in addition to the drain tanks dedicated to each purifier module for the collection of generated sludge.

The tanks are to be equipped with automatic transfer means, level indicator for local control and high level alarm given in a manned position connected to the automation system.

A hand pump is to be additionally provided which levers are to be located at floor level to facilitate operations; where this is not possible, a platform with a vertical ladder is provided for access to the pump.

Drain tanks of purifier modules are to be provided for each purifier skid, equipped with a high level alarm given to a manned position, connected to the Control and Monitoring Panel of each purifier.

Drain tanks are to be discharged to the Sludge Tank by means of a power operated pump. All discharge lines are sized to allow pumping without the need to heat the sludge.

1.1.21 Water-lubricated stern tube bearings *(1/1/2017)*

Stern tube bearings are to be water lubricated according to Pt C, Ch 1, Sec 7, [2.4.3], [2.4.4] and [2.4.6].

1.1.22 Magnetic coupling on oil pumps *(1/1/2017)*

Magnetic couplings are to be used to connect fuel oil and lubricating oil pumps and relevant drivers.

These couplings are to be approved by the Society.

1.1.23 Biodegradable and low aquatic toxicity lube oil *(1/1/2017)*

Biodegradable and low aquatic toxicity oils are to be used for the lubrication of machineries, apart from diesel engines, hydraulic systems and for oil to sea interface. Oil to sea interface include protective seals on controllable pitch propellers, azimuth thrusters, propulsion pods, rudder bearings, lubrication discharges from paddle wheel propulsion, stern tubes, thruster bearings, stabilizers, rudder bearings, azimuth thrusters, propulsion pod lubrication, and wire rope and mechanical equipment subject to immersion. The oil biodegradability characteristic and low aquatic toxicity are to be demonstrated by means of tests carried out according to a recognized standard.

1.1.24 Restrictions in the use of hydraulic plants *(1/1/2017)*

All manoeuvring systems (steering gear, watertight doors, hatches, valves etc) apart from the controllable pitch propeller actuating systems are not to be of hydraulic type.

1.2 Auxiliary Supply Ships

1.2.1 Segregated ballast tank *(1/1/2017)*

Every product carrier of 30.000 tonnes deadweight and above delivered after 1 June 1982 is to be provided with segregated ballast tanks and is to be complied with MARPOL, Annex I, regulation 18, paragraphs 2, 3, and 5 (where Administration in this contest means Society).

Every product carrier of 40.000 tonnes deadweight and above delivered on or before 1 June 1982 is to be provided with segregated ballast tanks and is to be complied with MARPOL, Annex I, regulation 18, paragraphs 2 and 3, or alternatively operate with dedicated clean ballast tanks in accordance with MARPOL, Annex I, regulation 18, paragraph 8 (where Administration in this contest means Society).

1.2.2 Protective location of segregated ballast *(1/1/2017)*

Every product carrier of 30.000 tonnes deadweight and above having segregated ballast tanks located within the cargo tank length, is to be complied with MARPOL, Annex I, regulation 18, paragraph 12.

1.2.3 Double hull and bottom *(1/1/2017)*

Every auxiliary supply ship of 600 tonnes deadweight and above delivered on or after 6 July 1996 is to be complied with MARPOL, Annex I, regulation 19.

Every auxiliary supply ship delivered on or before 6 July 1996 is to be complied with MARPOL, Annex I, regulation 19 (where Administration in this contest means Society).

1.2.4 Pump room bottom protection *(1/1/2017)*

Every auxiliary supply ship of 5.000 tonnes deadweight and above is to comply with MARPOL, Annex I, regulation 22.

1.2.5 Collision or stranding protection *(1/1/2017)*

Every auxiliary supply ship delivered on or after 1 January 2010 is to be complied with criteria of accidental oil outflow performance prescribed in MARPOL, Annex I, regulation 23.

Every auxiliary supply ship delivered before 1 January 2010 is to be complied with:

- criteria of hypothetical oil outflow performance prescribed in MARPOL, Annex I, regulation 25 and
- limitation of size and arrangement of cargo tanks prescribed in MARPOL, Annex I, regulation 26 considering the damage extension of regulation 24.

1.2.6 Intact stability *(1/1/2017)*

Every auxiliary supply ship of 5.000 tonnes deadweight and above is to be complied with MARPOL, Annex I, regulation 27.

1.2.7 Subdivision and damage stability *(1/1/2017)*

Every auxiliary supply ship of 150 gross tonnage and above is to be complied with subdivision and damage stability criteria of MARPOL, Annex I, regulation 28.

1.2.8 Slop tanks *(1/1/2017)*

Every auxiliary supply ship of 150 gross tonnage and above is to be provided with slop tanks and systems in compliance with MARPOL, Annex I, regulation 29 (where Administration in this contest means Society).

1.2.9 Discharge system *(1/1/2017)*

Every auxiliary supply ship is to be provided with the pumping, piping and discharge arrangement of MARPOL, Annex I, regulation 30: the same MARPOL limitation in term of size and delivery apply (where Administration in this contest means Society).

1.2.10 Oil discharge monitoring and control system *(1/1/2017)*

Every auxiliary supply ship of 150 gross tonnage and above is to be provided with oil/water interface detectors compliance with MARPOL, Annex I, regulation 32 (where Administration in this contest means Society).

1.3 Sewage

1.3.1 International Sewage Pollution Prevention Certificate *(1/1/2017)*

A certificate is to be issued under the provisions of the MARPOL Convention, Annex IV, by the society. The certificate is to be renewed within the time described by MARPOL.

In case the certificate has been issued with some exceptions, the index is to be weighted accordingly.

1.3.2 Sewage treatment plant of type approved (Resolution MEPC.2(VI)) *(1/1/2017)*

A sewage treatment plant, meeting operational requirements based on the standards and test methods as detailed in Resolution MEPC.2(VI), as amended, is to be installed on board.

1.3.3 Sewage treatment plant of type approved (Resolution MEPC.227(64)) *(1/1/2017)*

A sewage treatment plant of type approved is to be installed on-board. The society approves the plant taking into account the IMO guidelines (Resolution MEPC.227(64)).

1.3.4 Sewage treatment plant: effluent quality as per 33 CFR Part 159 Subpart E *(1/1/2017)*

A sewage treatment plant, meeting operational requirements based on the standards and test methods as detailed in 33 CFR Part 159 Subpart E is to be installed on board.

The system performance is to be certified.

1.3.5 Holding tank *(1/1/2017)*

The ship is to be equipped with holding tank(s) for treated sewage with sufficient capacity to allow storage of treated sewage when in port or in no discharge areas.

The discharge line is to be fitted with a standard discharge connection in accordance with regulation 10, Annex IV to MARPOL 73/78 as amended, or any other approved means of disposal.

The minimum total capacity of such tank(s) is to the satisfaction of the Society, considering the operation of the ship, the maximum number of persons on board and other factors. The litres of sewage to consider are:

- 96 litres/person/day in case of conventional (flushmeter) system
- 11 litres/person/day in case of vacuum system.

A high level alarm is to be given in a manned position and a mean to indicate visually the amount of contents of the tank is to be present.

1.3.6 Flanges for discharge connection *(1/1/2017)*

The sewage discharge pipelines are to be fitted with flange in accordance with the standard in MARPOL Convention, Annex IV, regulation 10.

1.3.7 Sewage discharge record book *(1/1/2017)*

All sewage discharges whether to sea or shore reception facilities are to be recorded in a dedicated record book with indication of

- the date, location, ship's speed (in case of discharge during navigation)
- quantity of sewage discharged and type (treated or untreated, mixed or not)
- in event of an emergency, accidental or other exceptional discharge of sewage, details of the circumstances and reasons for the discharge.

Each entry of a discharge is to be signed by the person in charge of the discharge concerned and each completed page is to be signed and dated by the master or other person having charge of the ship.

1.4 Grey water

1.4.1 Grey water and sewage treatment system *(1/1/2017)*

All grey waters are to be treated with sewage in a plant of type approved (in accordance with at least Resolution MEPC.2(VI)).

1.4.2 Grey water treatment system (VGP 2013) *(1/1/2017)*

A grey water treatment system, granting an effluent quality in compliance with standard detailed in VGP 2013, paragraph 5.1.1.1.2 Graywater Treatment Standards, is to be installed on board.

1.4.3 Holding tank *(1/1/2017)*

The ship is to be equipped with holding tank(s) for grey water with sufficient capacity to allow storage of grey water when in port for at least 2 days. The total capacity of grey water holding tanks is to be based on the maximum number of persons on board (i.e. maximum number of persons that can be accommodated in cabins) and 200 litres/person/day.

A high level alarm is to be given in a manned position.

If the same tanks are used to hold treated sewage and grey water, their capacity is to be at least the sum of the capacities for the treated sewage holding tanks in [1.3.5] and the tanks for grey water.

A smaller volume, in any case not lower than 50% of the above capacity, may be accepted provided that:

- the ship is equipped with a system for treating grey water, able to reduce the volume of the effluent (e.g. by reusing part of the treated grey water for on board use);
- 2 days' retention is ensured;
- technical documentation, including results of onboard tests, of the system's efficiency and of effluent volume reduction is documented to the satisfaction of the Society.

Grey water is always to be discharged at a distance of more than 4 nautical miles from the nearest land or to a reception facility.

The discharging criteria do not apply when the discharge of grey water is necessary for securing the safety of the ship and those on board, or saving life at sea, or when the discharge results from damage to the ship or its equipment.

1.4.4 Grey water record book *(1/1/2017)*

All grey water discharges whether to sea or shore reception facilities are to be recorded in a dedicated record book with indication of:

- the date, location and distance from the nearest land, quantity
- in event of an emergency, accidental or other exceptional discharge of sewage, details of the circumstances and reasons for the discharge

Each entry of a discharge is to be signed by the person in charge of the discharge concerned and each completed page is to be signed and dated by the master or other person having charge of the ship.

1.5 Garbage

1.5.1 Placards *(1/1/2017)*

Placards stating the prohibition and restrictions for discharging garbage from ships are to be fixed in conspicuous and prominent places where:

- crew works and lives,
- passengers are accommodated and congregate
- in areas where bins are placed for collection of garbage.

The placards are to be at least 12.5 cm by 20 cm, made of durable material. The placards are to be displayed at line of sight height and be printed in Italian and English.

1.5.2 Garbage Management Plan *(1/1/2017)*

A garbage management plan is to be present and followed on-board. The plan is to provide written procedures for minimizing, collecting, storing, processing and disposing of garbage, including the use of the equipment on board.

A person in charge of carrying out the plan is to be designated.

The plan is to be based on the IMO guidelines (Resolution MEPC.220(63)).

1.5.3 Garbage record keeping *(1/1/2017)*

A garbage record book is to be present on board. The basic information to report in the book is:

- Date, time (in case of incineration, time of start and stop)
- Position of ship
- Type of garbage
- Estimated amount discharged into sea or to reception facilities or incinerated (including accidental or other exceptional discharges)
- Signature of the officer in charge of the operation.

Receives or certificates delivered by the port reception facilities or the ship receiving the garbage are to be kept on board for 2 years.

1.6 Other sources

1.6.1 Ballast water exchange *(1/1/2017)*

A ballast water management plan, including a ballast water record book, is to be developed in accordance with Reg. D-1 of the IMO "International Convention for the control and management of ship's ballast water and sediments, 2004" and used for ballast water management.

Unless stricter requirements are enforced by the Port State, it is recommended that ballast water exchange is carried out during international voyages at not less than 200 miles from the nearest land or, if not possible, at not less than 50 miles from nearest land in a zone with water depth not less than 200 m. The ship is not to be required to deviate from its intended voyage, or delay the voyage in order to comply with these requirements.

Systems for the treatment of ballast water may be accepted in place of the ballast water exchange, subject to consideration by the Society.

1.6.2 Ballast water treatment *(1/1/2017)*

A ballast water treatment, plant complying with Reg. D-2 of the IMO "International Convention for the control and management of ship's ballast water and sediments, 2004", is to be installed onboard.

The system performance is to be certified.

1.6.3 Control of Harmful Anti-fouling Systems *(1/1/2017)*

Organotin compounds which act as biocides are not to be present in anti-fouling system of the ship. Alternatively the ship can use a coating that forms a barrier to such compounds leaching from the underlying noncompliant anti-fouling systems.

1.6.4 Marine growth prevention systems *(1/1/2017)*

Antifouling systems for pipings are to be based on environmentally friendly technologies, not discharging harmful products and approved by the Society.

1.6.5 Collection of spillage/ leakage of environmentally hazardous substances *(1/1/2017)*

Drip trays or coamings having sufficient height are to be provided on weather decks under equipment, systems and devices to collect spillage and or leakage of environmentally hazardous substances.

2 Prevention of air pollution

2.1 Ozone depleting substances

2.1.1 No ozone depleting substances (other than hydro-chlorofluorocarbons) *(1/1/2017)*

Installations which contain ozone depleting substances, other than hydro-chlorofluorocarbons, are not to be present on board.

2.1.2 No hydro-chlorofluorocarbons *(1/1/2017)*

Installations which contain ozone depleting substances, including hydro-chlorofluorocarbons, are not to be present on board.

2.1.3 Ozone depleting substances record book *(1/1/2017)*

A list of equipment containing ozone depleting substances and an Ozone Depleting Substances Record Book are to be present onboard.

Entries in the Ozone Depleting Substances Record Book are to be recorded in terms of mass (kg) of substance and are to be completed without delay on each occasion, in respect of the following:

- recharge, full or partial, of equipment containing ozone depleting substances;
- repair or maintenance of equipment containing ozone depleting substances;
- deliberate and not deliberate discharge of ozone depleting substances to the atmosphere:
- discharge of ozone depleting substances to land-based reception facilities; and
- supply of ozone depleting substances to the ship.

2.1.4 Restrictions in the use of GWP substances *(1/1/2017)*

Two alternatives may be chosen:

a) avoid the use of refrigerants having GWP > 2000 in refrigeration or air conditioning plant systems;

b) design refrigeration or air conditioning plant systems minimising piping systems carrying the refrigerant (e.g. systems that utilise an intermediate cooling medium for refrigerated cargo spaces/provision plants/AC Ventilation Units).

   The requirement does not apply to domestic type, standalone, refrigerators and air conditioning units.

The environmental index in Sec 1, Tab 2 is weighted multiplying by R, defined as follows:

$R = (P_{TOT} - P_{GWP>2000}) / P_{TOT}$

Where:

$P_{GWP>2000}$ = Refrigerating capacity at - 10°C evaporating temperature and + 25°C condensing temperature of refrigerating plants utilising refrigerants with GWP > 2000 excluding those complying with (b).

P_{TOT} = Refrigerating capacity at - 10°C evaporating temperature and + 25°C condensing temperature of any refrigerating plant independently from the utilised medium [kcal/h].

2.2 Green House Gases and Pollutants

2.2.1 Non fossil fuels *(1/1/2017)*

Where power on board is partially or totally produced with systems which do not use fossil fuels (e.g. sails, fuel cells, etc.), the environmental index in Sec 1, Tab 2 is weighted multiplying by R, defined as follows:

$R = \Sigma P_{non\ fossil\ fuels} / \Sigma P_{TOT}$

Where:

$P_{non\ fossil\ fuels}$ = Nominal power of each power source not using fossil fuel [kW]

P_{TOT} = Nominal power of each power source independently from the utilized fuel [kW]

2.2.2 Second generation of bio-fuels *(1/1/2017)*

Where second generation bio-fuels are partially or totally used on board, the environmental index in Sec 1, Tab 2 is weighted multiplying by R, defined as follows:

$R = \Sigma P_{sgbf} / \Sigma P_{TOT}$

Where:

P_{sgbf} = Nominal power of each user which utilizes second generation bio-fuel [kW]

P_{TOT} = Nominal power of each user independently from the utilized fuel [kW]

2.2.3 Cold ironing *(1/1/2017)*

The ship is to be provided with an installation allowing the ship to be electrically fed from shore.

2.2.4 Tool to manage handling and consumption of fuels *(1/1/2017)*

The ship is to be provided with a system to monitor and record:

a) fuel supplies to the ship and

b) fuel consumption of the ship.

Data may be inserted manually.

2.2.5 Computerized system to monitor fuel consumption *(1/1/2017)*

Engine room automation system or an independent computerised tool has to include means for continuous monitoring the fuel consumption at least of the following users:

- propulsion engines
- diesel generators
- oil fired boilers
- other oil fired users (e.g. inert gas generators).

2.2.6 Support tool to assist the Master in keeping most efficient sailing draft and trim *(1/1/2017)*

The ship is to be fitted with means capable to support the Master in keeping most efficient sailing draft and trim.

2.2.7 Energy saving and energy conservation *(1/1/2017)*

The ship is to be provided with an operational manual, acceptable to the Society, indicating the procedures used on board to comply with energy saving and energy conservation criteria.

At least the following areas are to be considered in the manual:

- propulsion
- electric production
- electric users for propulsion
- electric users for hull services (steering, thrusters, bilge, ballast)
- electric users for navigation
- electric users for hotel/accommodation services (galley, laundries, lighting and A/C etc)
- steam production and users.

2.2.8 Fuel consumption Decision Support Solution *(1/1/2017)*

The ship is to be provided with a correlation study, acceptable to the Society, among the parameters listed in [2.2.6] or other identified as key parameters for the reduction of fuel oil consumption of the particular ship.

The ship is to be provided with all the necessary devices for the data collection including those relevant to: draft, trim, power RPM, speed, weather conditions (wind, waves, currents, etc).

The monitoring of these parameters affecting the consumption performance is to be carried out for a time period significant in respect of the ship's trade.

Collected data are to be analyzed to identify the best setting in terms of optimal fuel consumption, route by route.

2.2.9 Optimization of Air Conditioning (AC) plant *(1/1/2017)*

Means are to be provided to optimize AC plant, including the use of passive means to decrease AC demand (e.g. reflective glazing).

2.2.10 Low energy consumption lights *(1/1/2017)*

At least 80% in power of the lighting fittings is to be of low consumption type.

2.2.11 Hull transom design *(1/1/2017)*

Means are to be adopted to increase propulsion efficiency by minimum 0.5% at design speed and relevant calculations or evidence are to be submitted.

2.2.12 Stabilizer openings *(1/1/2017)*

Openings in way of fin stabilizers are to be fitted with suitable means to restore the hull boundary continuity when fins are not in operation.

2.2.13 Silicone-based antifouling paint *(1/1/2017)*

A silicone-based paint, which decreases the hull frictional resistance, is to be used as hull antifouling system.

2.2.14 Fluor-polymer antifouling paint *(1/1/2017)*

A fluor-polymer-based paint, which decreases the frictional resistance, is to be used as hull antifouling system.

2.2.15 Fins on propeller boss cups *(1/1/2017)*

Suitable propeller boss fins are to be fitted on the propeller to guide the water stream in order to reduce vortex and increase the propeller efficiency.

2.2.16 High-performing propellers *(1/1/2017)*

The ship is to be fitted with high performing propellers (capable to increase propulsion efficiency by minimum 1% at design speed) characterized by a double-side or a single-side arc brim provided at the tip of each blade. Relevant calculations or evidence are to be submitted.

2.2.17 High-efficiency motors *(1/1/2017)*

The ship is to be fitted with high efficiency (IE2) or premium efficiency (IE3) motors, according to IEC 60034-30.

For motors having a rated power of 100 kW and above, the tests to determine the rated efficiency are to be carried out under survey, and are to be part of the motor testing documentation.

The environmental index will be assigned as per Tab 1.

Table 1 : Environmental indexes *(1/1/2017)*

Installation	Environmental index
High and premium efficiency motors are installed, with an aggregate power of more than 80% of the ship aggregate electric motor power	3
High and premium efficiency motors are installed, with an aggregate power of more than 50% but less than 80% of the ship aggregate electric motor power	2
High and premium efficiency motors are installed, with an aggregate power of more than 20% but less than 50% of the ship aggregate electric motor power	1

2.3 Nitrogen Oxides

2.3.1 Tier 1 *(1/1/2017)*

All marine diesel engines installed on board are to be in accordance with the NOx limits prescribe in MARPOL, Annex VI, regulation 13, paragraph 3.

Diesel engines, which are not subject to MARPOL Annex VI, regulation 13, are not to be taken into account.

2.3.2 Tier 2 *(1/1/2017)*

All marine diesel engines installed on board are to be in accordance with the NOx limits prescribe in MARPOL, Annex VI, regulation 13, paragraph 4.

Diesel engines, which are not subject to MARPOL Annex VI, regulation 13, are not to be taken into account.

2.3.3 Tier 3 *(1/1/2017)*

All marine diesel engines installed on board are to be in accordance with the NOx limits prescribe in MARPOL, Annex VI, regulation 13, paragraph 5.

Diesel engines, which are not subject to MARPOL Annex VI, regulation 13, are not to be taken into account.

2.3.4 Gas to liquids (GTL) fuels *(1/1/2017)*

Where GTL fuels are partially or totally used on board, the environmental index in Sec 1, Tab 2 is weighted multiplying by R, defined as follows:

$R = \Sigma P_{GTL} / \Sigma P_{TOT}$

Where

P_{GTL} = Nominal power of each user which utilizes GTL fuel [kW]

P_{TOT} = Nominal power of each user independently from the utilized fuel [kW]

Diesel engines, which are not subject to reg. 13 of MARPOL Annex VI, are not to be taken into account.

2.3.5 Fuel treatment *(1/1/2017)*

Where fossil fuel pre-treatment (e.g. water emulsion), or water injection into combustion chamber, or scavenging air, or combination of these are partially used on board, the environmental index in Sec 6, Tab 2 is weighted multiplying by R, defined as follows:

$R = \Sigma P_{FT} / \Sigma P_{TOT}$

Where

P_{FT} = Nominal power of each user which utilizes fuel treatment [kW]

P_{TOT} = Nominal power of each user independently from the utilized fuel [kW]

Diesel engines, which are not subject to Regulation 13 of MARPOL Annex VI, are not to be taken into account.

2.3.6 Dual-fuel engines running with LNG *(1/1/2017)*

The fuel used on board is to be LNG (gasoil only used as back-up in emergency).

Diesel engines, which are not subject to Regulation 13 of MARPOL Annex VI, are not to be taken into account.

Depending on installation a weighted index may be necessary.

2.3.7 Exhaust gas treatment *(1/1/2017)*

Each diesel engine subject to Regulation 13 of MARPOL Annex VI is to be fitted with an exhaust gas treatment system which abates not less than 85% the total generated NOx and which does not increase total fuel consumption at the engine maximum continuous rating by more than an averaged 2%.

The system is to be acceptable to the Society in compliance with Sec 6, [8] as applicable.

Depending on installation a weighted index may be necessary.

2.3.8 NOx emissions monitoring and recording *(1/1/2017)*

The ship is to be fitted with system for monitoring and recording the NOx emissions from diesel engines and boilers.

Diesel engines, which are not subject to Regulation 13 of MARPOL Annex VI, are not to be taken into account.

The system is to be acceptable to the Society in compliance with Sec 6, [8] as applicable.

2.4 Sulphur Oxides

2.4.1 SOx limits (global 3,5 % and 0,1 % in SECA) *(1/1/2017)*

The sulphur content of fuel used on board ships (average percentage calculated on a yearly basis) is not to exceed 3.5% by mass, except when the ship is operating in SOX emission control area (SECA) where the fuel burned is not to exceed the limit of 0.1% m/m. SECA are the area established by IMO.

In case of new ship (in other words, ship not yet sailing) a declaration about the S content fuels that will be used, is to be considered acceptable.

2.4.2 SOx (global 1,0 % and 0.5% and 0.1% in SECA) *(1/1/2017)*

The sulphur content of fuel used on board ships (average percentage calculated on a yearly basis) is not to exceed 1.0% by mass, except when the ship is operating in SOX emission control area (SECA) where the fuel burned is not to exceed the limit of 0.1% m/m. SECA are the area established by IMO.

In case of new ship (in other words, ship not yet sailing) a declaration about the S content fuels that will be used, is to be considered acceptable.

2.4.3 SOx limits (0,1 %) *(1/1/2017)*

The sulphur content of fuel oil used on board ships (average percentage calculated on a yearly basis) is not to exceed 0,1 % by mass worldwide.

In case of new ship (in other words, ship not yet sailing) a declaration about the S content fuels that will be used, is to be considered acceptable.

2.4.4 Gas to liquids (GTL) fuels *(1/1/2017)*

Where GTL fuels are partially or totally used on board, the environmental index in Sec 6, Tab 2 is weighted multiplying by R, defined as follows:

$R = \Sigma P_{GTL} / \Sigma P_{TOT}$

Where

P_{GTL} = Nominal power of each user which utilizes GTL fuel [kW]

P_{TOT} = Nominal power of each user independently from the utilized fuel [kW].

2.4.5 Blending fossil fuel with second-generation bio-fuels *(1/1/2017)*

Where blending (of fossil fuel with second generation bio-fuels), ensuring a sulphur content not exceeding 1,0% by mass, are partially or totally used on board, the environmental index in Sec 6, Tab 2 is weighted multiplying by R, defined as follows:

$R = \Sigma P_{sgbf} / \Sigma P_{TOT}$

Where

P_{sgbf} = Nominal power of each user which utilizes blending [kW]

P_{TOT} = Nominal power of each user independently from the utilized fuel[kW]

2.4.6 Dual-fuel engines running with LNG *(1/1/2017)*

The fuel used on board is to be LNG (gas oil only used as back-up in emergency).

Diesel engines, which are not subject to Regulation 13 of MARPOL Annex VI, are not to be taken into account.

Depending on installation a weighted index may be necessary.

2.4.7 Exhaust gas treatment *(1/1/2017)*

Each diesel engine subject to MARPOL, Annex VI, Regulation 13, is to be fitted with an exhaust gas treatment system which abates not less than 85% the total generated SOX and which does not increase total fuel consumption at the engine maximum continuous rating by more than an averaged 2%.

The system is to be acceptable to the Society in compliance with Sec 6, [8] as applicable.

Depending on installation a weighted index may be necessary.

2.4.8 SOx emissions monitoring and recording *(1/1/2017)*

The ship is to be fitted with system for monitoring and recording the SOx emissions from diesel engines and boilers.

Diesel engines, which are not subject to Regulation 13 of MARPOL Annex VI, are not to be taken into account.

The system is to be acceptable to the Society in compliance with Sec 6, [8] as applicable.

2.5 Volatile organic compounds

2.5.1 Vapour emission control system *(1/1/2017)*

A vapour emission collection system approved by the Society is to be installed on board.

2.6 Particulates

2.6.1 Gas to liquids (GTL) fuels *(1/1/2017)*

Where GTL fuels are partially or totally used on board the environmental index in Sec 6, Tab 2 is weighted multiplying by R, defined as follows:

$R = \Sigma P_{GTL} / \Sigma P_{TOT}$

Where

P_{GTL} = Nominal power of each user which utilizes GTL fuel [kW]

P_{TOT} = Nominal power of each user independently from the utilized fuel [kW]

Diesel engines, which are not subject to Regulation 13 of MARPOL Annex VI, are not to be taken into account.

2.6.2 Fuel treatment *(1/1/2017)*

Where fossil fuel pre-treatment (e.g. water emulsion), or water injection into combustion chamber, or scavenging air, or blending of pre-treated fossil fuel with second-generation bio-fuels or combination of these are partially used on board, the environmental index in Sec 6, Tab 2 is weighted multiplying by R, defined as follows:

$R = \Sigma P_{FT} / \Sigma P_{TOT}$

Where

P_{FT} = Nominal power of each user which utilizes fuel treatment [kW]

P_{TOT} = Nominal power of each user independently from the utilized fuel [kW]

Diesel engines, which are not subject to Regulation 13 of MARPOL Annex VI, are not to be taken into account.

2.6.3 Prime movers modifications *(1/1/2017)*

Where modification in prime movers (e.g. common rail) are carried out, to achieve lower PMs emission without increasing other pollutant and GHG emissions, only partially, the environmental index in Sec 6, Tab 2 is weighted multiplying by R, defined as follows:

$R = \Sigma P_{mpm} / \Sigma P_{TOT}$

Where

P_{mpm} = Nominal power of modified prime movers [kW]

P_{TOT} = Nominal power of each prime mover independently if modified or not [kW]

Diesel engines, which are not subject to Regulation 13 of MARPOL Annex VI, are not to be taken into account.

2.6.4 Dual-fuel engines running with LNG *(1/1/2017)*

The fuel used on board is to be LNG (gasoil only used as back-up in emergency).

Diesel engines, which are not subject to Regulation 13 of MARPOL Annex VI, are not to be taken into account.

Depending on installation a weighted index may be necessary.

2.6.5 Exhaust gas treatment *(1/1/2017)*

Each diesel engine subject to Regulation 13 of MARPOL Annex VI is to be fitted with an exhaust gas treatment system which abates not less than 85% the total generated PMs, as determined according to ISO 8178 Standard or equivalent, and which does not increase total fuel consumption at the engine maximum continuous rating by more than an averaged 2%.

The system is to be acceptable to the Society in compliance with Sec 6, [8] as applicable.

Depending on installation a weighted index may be necessary.

2.7 Carbon Dioxide (CO_2)

2.7.1 Gas to liquids (GTL) fuels *(1/1/2017)*

Where GTL fuels are partially or totally used on board for CO_2 reduction, the environmental index in Sec 6, Tab 2 is weighted multiplying by R, defined as follows:

$R = \Sigma P_{GTL} / \Sigma P_{TOT}$

Where

P_{GTL} = Nominal power of each user which utilizes GTL fuel [kW]

P_{TOT} = Nominal power of each user independently from the utilized fuel [kW]

Diesel engines, which are not subject to Regulation 13 of MARPOL Annex VI, are not to be taken into account.

2.7.2 Blending fossil fuel with second-generation bio-fuels *(1/1/2017)*

Where blending (of fossil fuel and second generation bio-fuels) are partially or totally used on board for CO_2 reduction, the environmental index in Sec 6, Tab 2 is weighted multiplying by R, defined as follows:

$R = \Sigma\ P_{sgbf} / \Sigma\ P_{TOT}$

Where:

P_{sgbf} = Nominal power of each user which utilizes blending [kW]

P_{TOT} = Nominal power of each user independently from the utilized fuel [kW]

2.7.3 Dual-fuel engines running with LNG *(1/1/2017)*

The fuel used on board is to be LNG (gas oil only used as back-up in emergency).

Diesel engines, which are not subject to Regulation 13 of MARPOL Annex VI, are not to be taken into account.

Depending on installation a weighted index may be necessary.

2.7.4 CO_2 emissions monitoring and recording *(1/1/2017)*

The ship is to be fitted with system for monitoring and recording the CO_2 emissions from diesel engines and boilers.

Diesel engines, which are not subject to Regulation 13 of MARPOL Annex VI, are not to be taken into account.

The system is to be acceptable to the Society in compliance with Sec 6, [8] as applicable.

2.8 Noise

2.8.1 Noise level assessment and implementation of noise mitigation measures *(1/1/2017)*

An underwater noise assessment (for normal navigation) is to be carried out identifying the appropriate measures to minimize impact and disturbance to marine species in general.

The measures may affect:

- propeller design and propulsion system for example reducing cavitation and/ or turbulence in the wake field
- hull form optimization for example reducing hull resistance.

Noise measurements assessing the effectiveness of the implemented measures are to be carried out annually.

The underwater noise measurements are to be conducted in accordance with international standards.

The noise assessment and the measurements are to be submitted to the Society for information.

2.9 Ship at scrap

2.9.1 Inventory of hazardous materials *(1/1/2017)*

An inventory of hazardous materials is to be developed taking into account the IMO Guidelines (Resolution MEPC.269(68)).

3 Procedures

3.1

3.1.1 *(1/1/2017)*

The Ship Environmental Management Plan, referred to in Sec 6, [4.1.2], is to include procedures covering the following:

- oily waste management including discharge criteria;
- preparation, filling in and maintenance of the oil record book;
- restriction of use of fuel tank as ballast tank (if item 1.1.13 is adopted
- restriction of use of forepeak tanks (if item 1.1.16 is adopted)
- periodical calibration of the oil content meters, when required by the Manufacturer's instructions or, in the absence of specific indications, at least every six months; documentation is to be kept on board for examination during periodical surveys;
- periodical cleaning of the oil bilge water retention tank, bilge holding tank and of the sludge tank
- bunkering operation, including bunkering in navigation
- periodical checks of the overflow systems/alarms;
- sewage management including discharge criteria and use of holding tanks in port and no discharge areas;
- preparation, filling in and maintenance of the sewage record book;
- disposal of sewage treatment plant residues. If the ship is not in a condition to dispose at sea of sewage treatment plant residues in accordance with international or national regulations, such residues are to be disposed ashore or by incineration;
- grey water discharge criteria and use of holding tanks in ports and in no discharge areas;
- garbage management and waste recycling;
- procedures to be followed to minimise the risk of depleting the refrigerant or the refrigerant vapours in all operative and emergency conditions;
- corrective actions in the event the annual refrigerant leakage exceeds 10%;
- preparing, filling in and updating the refrigerant log-book. The leakage is to be documented by consumption figures recorded in a refrigerant log-book to be kept on board and made available during periodical surveys;
- the procedures required by MARPOL 73/78 as amended or the reference to the company document containing them.

The lube oil consumption of all systems having an oil to sea interface, such as main and auxiliary engines cooled by sea water, controlled pitch propellers, sterntubes, bow and stern thrusters, stabilisers, PODs etc, is to be recorded at least once a week in an "Oil Systems record book" aimed at detecting, through unusually high consumption, oil leakage through sealings.

The log-book is to contain the list of all systems concerned, the consumption of each system recorded at least every week and corrective actions when carried out.ut.