

Rules for the Classification of Ships

Effective from 1 January 2021

Part F

Additional Class Notations

EXPLANATORY NOTE TO PART F

1. Reference edition

The reference edition for Part F is this edition effective from 1 January 2016.

2. Amendments after the reference edition

2.1 Except in particular cases, a new edition of the Rules is published annually.

3. Effective date of the requirements

3.1 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 the last updating. The effective date of all those requirements not followed by any date shown in brackets is that of the reference edition.

3.2 Item 6 below provides a summary of the technical changes from the preceding edition. In general, this list does not include those items to which only editorial changes have been made not affecting the effective date of the requirements contained therein.

4. Rule Variations and Corrigenda

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

5. Rule subdivision and cross-references

5.1 Rule subdivision

The Rules are subdivided into six parts, from A to F.

Part A: Classification and Surveys

Part B: Hull and Stability

Part C: Machinery, Systems and Fire Protection

Part D: Materials and Welding

Part E: Service Notations

Part F: 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.

5.2 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.

6. Summary of amendments introduced in the edition effective from 1 January 2021

This edition of Part F contains amendments whose effective date is **1 January 2021**.

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

Part F
Additional Class Notations

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CHAPTER 3	AUTOMATION SYSTEMS (AUT)
CHAPTER 4	INTEGRATED SHIP SYSTEMS
CHAPTER 5	MONITORING EQUIPMENT (MON)
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Part F
Additional Class Notations

Chapter 1

**SYSTEM OF TRACE AND ANALYSIS OF RECORDS
(STAR)**

SECTION 1 STAR-HULL

SECTION 2 STAR-MACH

APPENDIX 1 ACCEPTANCE CRITERIA FOR ISOLATED AREAS OF ITEMS

APPENDIX 2 ACCEPTANCE CRITERIA FOR ISOLATED ITEMS

APPENDIX 3 ACCEPTANCE CRITERIA FOR ZONES

APPENDIX 4 PITTING INTENSITY DIAGRAMS

APPENDIX 5 OWNER'S HULL INSPECTION REPORTS

APPENDIX 6 RISK ANALYSIS FOR STAR-MACH

SECTION 1

STAR-HULL

1 General

1.1 Principles

1.1.1 Application

The additional class notation **STAR-HULL** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.2.2], to ships complying with the requirements of this Section.

1.1.2 Scope

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

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

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

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

1.1.3 Safety management system

The Inspection and Maintenance Plan required under the scope of the **STAR-HULL** notation may form part of the Safety Management System to be certified in compliance with the ISM Code.

1.2 Conditions for the assignment and maintenance of the notation

1.2.1 Assignment of the notation

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

- a request for the notation is to be sent to the Society:
 - signed by the party applying for the classification, in the case of new ships
 - signed by the Owner, in the case of existing ships

- the following documents are to be submitted to the Society by the Interested Party:
 - plans and documents necessary to carry out the structural analysis, and information on coatings and on cathodic protection (see [2.1])
 - the hot spot map of the structure (see [2.2])
 - the Inspection and Maintenance Plan to be implemented by the Owner (see [2.3])
 - information concerning the ship database and relevant electronic support to be implemented by the Owner (see [1.3.1])
- the Society reviews and approves the Inspection and Maintenance Plan, taking into account the results of the structural analysis, as well as the information concerning the ship database
- the Society carries out an initial shipboard audit to verify the compliance of the procedures on board with respect to the submitted documentation.

1.2.2 Maintenance of the notation

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

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

1.3 Ship database

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

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

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

1.3.2 The ship database is to be:

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

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

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

This ship database is to be transmitted to the Society at least every six months. It may be agreed between the Owner and the Society that the required data are automatically down-

loaded into the Society's ship database after they are collected.

2 Documentation to be submitted

2.1 Plans and documents to be submitted

2.1.1 Structural analysis

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

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

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

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

2.1.2 Coatings

The following information on coatings is to be submitted:

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

2.1.3 Cathodic protection

The following information on sacrificial anodes is to be submitted:

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

2.2 Hot spot map

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

- items (such as a plating panels, ordinary stiffeners or primary supporting members) for which the structural analysis carried out at the design stage showed that the ratio between the applied loads and the allowable limits exceeded 0,975
- items identified as "hot spot item" during the structural reassessment, according to App 2
- structural details subjected to fatigue, based on the list defined in Pt B, Ch 12, App 1
- other items, depending on the results of the structural analyses and/or on experience.

2.2.2 The hot spot map may indicate which items are to be inspected periodically under the Owner's responsibility.

2.3 Inspection and Maintenance Plan (IMP)

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

The Inspection and Maintenance Plan is to include:

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

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

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

3 Inspection and Maintenance Plan (IMP)

3.1 Minimum requirements

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

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

3.1.3 The IMP performed at periodical intervals does not prevent the Owner from carrying out occasional inspections and maintenance as a result of an unexpected failure or event (such as damage resulting from heavy weather or cargo loading/unloading operation) which may affect the hull or hull equipment condition.

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

3.2 General scope of IMP

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

- deck area structure
- hatch covers and access hatches
- deck fittings
- steering gear
- superstructures
- shell plating
- ballast tanks, including peaks,
- cargo holds, cargo tanks and spaces
- other accessible spaces
- rudders
- sea connections and overboard discharges
- sea chests
- propellers.

3.3 Periodicity of inspections

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

- Type 1: two inspections every year, with the following principles:
 - one inspection is to be carried out outside the window provided for the execution of the annual class survey, in the vicinity of the halfway date of the anniversary date interval

- the other inspection is to be carried out preferably not more than two months before the annual class survey is conducted
- the minimum interval between any two consecutive inspections of the same item is to be not less than four months.

- Type 2: inspection at annual intervals, preferably not more than four months before the annual class survey is carried out.
- Type 3: inspection at bottom surveys.

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

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

For ships less than 5 years old, 25% in number of ballast tanks (with a minimum of 1) are to be inspected annually, in rotation, so that all ballast tanks are inspected at least once during the 5-year class period.

For ships 5 years old or more, all ballast tanks are to be inspected annually.

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

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

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

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

In addition, the requirement under Pt A, Ch 2, Sec 2, [7.1.2] is to be complied with.

3.4 Extent of inspections

3.4.1 Deck area structure

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

When structural defects affecting the class (such as fractures or deformations) are found, the Society is to be called for occasional survey attendance. If such structural defects are repetitive in similar areas of the deck, a program of addi-

tional close-up surveys may be planned at the Society's discretion for the next inspections.

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

3.4.2 Hatch covers and small hatches

Cargo hold hatch covers and related accessories are to be visually examined and checked for operation under the same scope as that required for annual class survey in. The condition of coating is to be assessed.

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

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

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

3.4.3 Deck fittings

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

- Piping on deck

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

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

- Vent system

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

Any defective item is to be dealt with.

- Ladders, guard rails, bulwarks, walkways

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

Any defective item is to be dealt with.

- Anchoring and mooring equipment

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

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

The manufacturer's maintenance requirements, if any, are to be complied with.

- Other deck fittings

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

3.4.4 Steering gear

The inspection of the installation is to cover:

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

3.4.5 Superstructures

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

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

Any defective item is to be dealt with.

3.4.6 Shell plating

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

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

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

3.4.7 Ballast tanks

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

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

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

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

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

3.4.8 Cargo holds and spaces

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

Cargo tanks are to be overall surveyed with regards to:

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

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

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

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

3.4.9 Other accessible spaces

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

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

3.4.10 Rudder(s)

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

Condition of connection with rudder stock is to be verified.

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

3.4.11 Sea connections and overboard discharges

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

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

3.4.12 Sea chests

Sea chests have to be examined with regards to:

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

3.4.13 Propellers

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

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

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

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

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

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

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

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

3.5 Inspection reports

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

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

3.5.2 The inspection reports are to include the following.

- General information such as date of inspection/maintenance, identification of the person performing the inspection with his signature, identification of the area/space/equipment inspected.
- For inspection of structural elements (deck area, hatch covers and small hatches, superstructures, ballast tanks,

dry cargo holds and spaces, other spaces), the report is to indicate:

- coating condition of the different boundaries and internal structures and, if any, coating repairs
- structural defects, such as fractures, corrosion (including pitting), deformations, with the identification of their location, recurrent defects
- condition of fittings related to the space inspected, with description as necessary of checks, working tests, dismantling, overhaul
- For inspection of equipment (deck equipment, sea connections and overboard discharges), the report is to indicate the results of visual examination, working tests, dismantling, repairs, renewal or overhaul performed.

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

- location and dimension of fractures, pitting, deformations
- condition of equipment before repairs
- measurements taken.

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

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

3.6 Changes to Inspection and Maintenance Plan

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

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

4 Acceptance criteria

4.1 Coating assessment

4.1.1 Criteria

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

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

4.1.2 Repairs

The procedures for repairs of coatings are to follow the coating manufacturer’s specification for repairs, under the Owner’s responsibility.

Table 2 : Acceptance criteria for coatings

Condition	Acceptance criteria
Ships less than 10 years old	Coatings in GOOD condition
Ships 10 years old or more	Coatings in GOOD or FAIR condition
Note 1:	
GOOD	: only minor spot rusting
FAIR	: local breakdown at edges of stiffeners and weld connections and/or light rusting over 20% or more of areas under consideration, but less than as defined for POOR condition
POOR	: general breakdown of coating over 20% or more of areas or hard scale at 10% or more of areas under consideration.

4.2 Sacrificial anode condition

4.2.1 Criteria

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

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

Table 3 : Acceptance criteria for sacrificial anodes

Condition	Percentage of loss in weight
Ships less than 10 years old	Less than 25
Ships 10 years old or more	Less than 50

4.3 Thickness measurements

4.3.1 General

The acceptance criteria for measured thicknesses are indicated in:

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

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

4.3.2 Isolated area

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

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

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

4.3.3 Item

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

If the criteria of measured thicknesses are not fulfilled for an item, then this item is to be repaired or replaced. Where the criteria are fulfilled but substantial corrosion as defined in Pt A, Ch 2, Sec 2, [2.2.9] is found, the IMP is to be adjusted to increase the frequency and/or extent of the maintenance program. In any case, for the items which contribute to the hull girder longitudinal strength, the criteria in [4.3.4] are to be considered.

4.3.4 Zone

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

- deck zone
- neutral axis zone
- bottom zone.

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

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

4.4 Pitting

4.4.1 Pitting intensity

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

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

4.4.2 Acceptable wastage

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

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

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

4.4.3 Repairs

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

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

Table 4 : Pitting intensity and corresponding acceptable wastage in pits

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

4.5 Fractures

4.5.1 General

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

In particular, fractures occur at the following locations:

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

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

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

4.5.2 Criteria

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

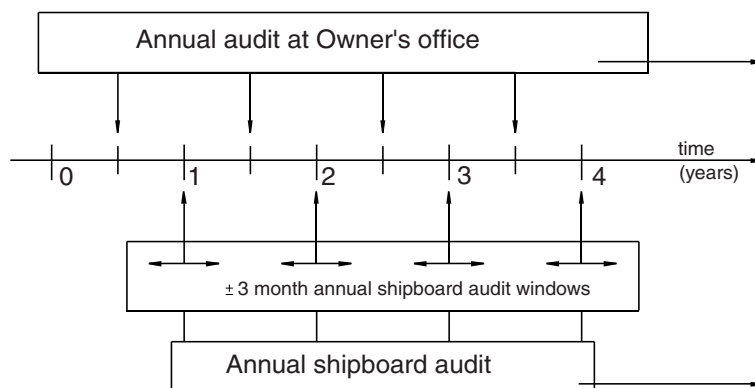
5 Maintenance of the notation

5.1 Annual audit at the Owner's offices

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

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

Figure 1 : Audit periodicity



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

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

Depending on this evaluation, the Society may call for:

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

5.1.3 The annual audit at the Owner's offices performed before the commencement of the class renewal survey is to include the planning required for this survey (see [5.3.2]).

5.2 Annual shipboard audit

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

5.2.2 During this audit the Surveyor:

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

5.3 Class renewal survey

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

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

5.3.2 For ESP ships, the planning of the class renewal survey as required in Part A, Chapter 4 is to be used.

For ships other than ESP ships, the planning of the class renewal survey is to be prepared in advance of the survey by the Owner in cooperation with the Society. This planning is preferably to be agreed during the annual audit at the Owner's offices performed approximately eighteen months before the due date of the class renewal survey (see [5.1.3]).

The planning is to include the following information:

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

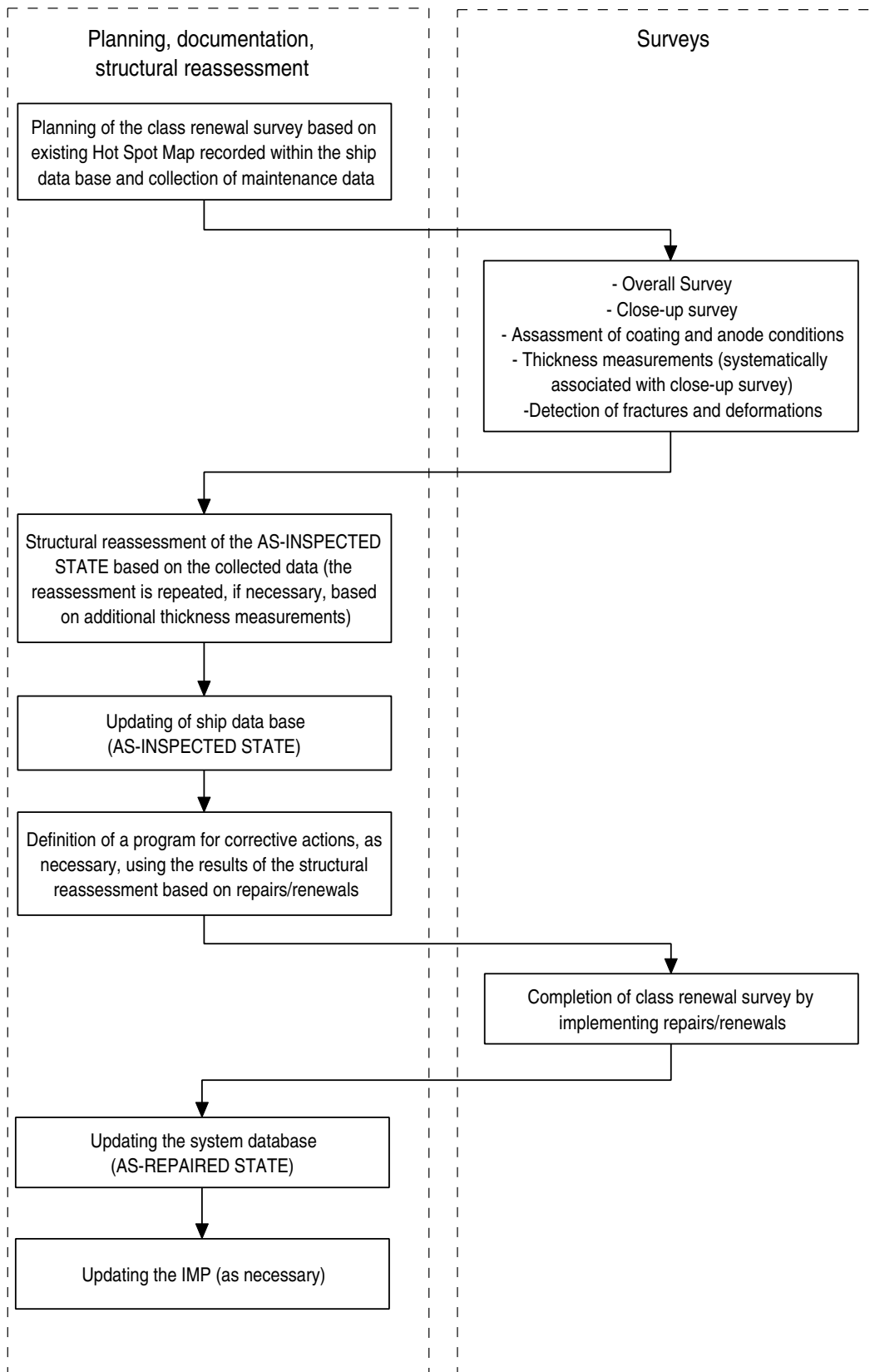
It is to take account of:

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

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

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

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



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

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

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

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

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

5.4 Suspension and withdrawal of the notation

5.4.1 (1/7/2020)

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

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

5.4.2 (1/7/2020)

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

- The condition of the ship is below the minimum level required for class (e.g. scantling of a hull structure below the corrosion margin). The action to be taken is either the immediate repair or the imposition of a condi-

tion of class (if acceptable) and suspension of the **STAR-HULL** notation. However, in cases where the condition of class is of a minor nature, the notation may not be suspended.

- The condition of the ship is below the minimum level for the **STAR-HULL** notation, but still above the level for the class (e.g. the scantling of a hull structure is below the corrosion margin acceptable for the notation but is still above the corrosion margin). The action to be taken is either the immediate repair or the imposition of a condition of class for the **STAR-HULL** notation (without the imposition of a condition of class).
- The Inspection and Maintenance Plan is not complied with (e.g. delays in performing the operations programmed according to the plan or the scope of inspection and/or maintenance not completely fulfilled), and/or the maintenance of the database is not fulfilled.

The action to be taken is:

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

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

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

SECTION 2

STAR-MACH

1 General

1.1 Principles

1.1.1 Application

The additional class notation **STAR-MACH** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.2.3] to ships complying with the requirements of this Section.

1.1.2 Procedure

The **STAR-MACH** notation reflects the fact that the Planned Maintenance Scheme (PMS) on board in accordance with Ch 12, Sec 1 is integrated with items highlighted by risk-based considerations and is periodically updated on the basis of the onboard experience. This procedure can include periodical and corrective maintenance, condition-monitoring as well as periodical and occasional inspections of machinery installations and equipment, and is to be operated on board and at the Owner's offices. This procedure is to be part of the PMS manual and may include equipment outside the scope of the classification.

The implementation of this procedure is verified by the Society through:

- a risk analysis, initially performed by the Society itself, or by the Owner with the approval of the Society in order to identify critical machinery and equipment items that are to be covered
- periodical update on the basis of the onboard corrective and preventive maintenance experience
- periodical examination of the data recorded by the Owner and made available to the Society through an electronic ship database suitable for consultation; and
- periodical audits carried out by the Society at the Owner's offices and on board.

1.1.3 Risk analysis

Within the framework of **STAR-MACH**, the purpose of the risk analysis is to review the preventive and corrective maintenance process on the basis of the risk of failures of the equipment of the ship systems, where the 'risk' of an event is defined as the combination of its probability and consequences.

The risk analysis is to include at least the equipment belonging to the following systems:

- Propulsion
- Electrical Production
- Steering gear,

including the auxiliaries that are essential for the functionality of the aforesaid systems.

The Society, upon agreement with the Owner, may vary the scope of the risk analysis to encompass different or addi-

tional equipment or systems that are considered critical, depending on the ship type and service.

The risk analysis process, its results and the proposed risk reduction measures are to be included in a report, which is to constitute a part of the PMS manual.

1.1.4 Class renewal survey

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

The combination of the maintenance plan implemented by the Owner and the results of the risk analysis enables the improvement of the PMS.

1.1.5 Manufacturer's recommendations

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

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

1.1.6 Safety Management System

The risk analysis report required under the scope of the **STAR-MACH** notation may be part of the Safety Management System to be certified in compliance with the ISM Code.

1.2 Conditions for the assignment and maintenance of the notation

1.2.1 Assignment of the notation

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

- a) a request for the notation is to be sent to the Society:
 - signed by the party applying for the classification in the case of new ships, or
 - signed by the Owner in the case of existing ships;
- b) the Society or the Owner performs the risk analysis for the selected systems;
- c) the Society reviews and approves the PMS, which includes the risk analysis report, taking into account the results of the above-mentioned risk analysis as well as the information concerning the ship database (for existing ships);

- d) the Society carries out an initial shipboard audit to verify the compliance of the procedures on board with respect to the documentation submitted.

The documentation to be submitted to the Society by the interested party is listed in [2].

1.2.2 Maintenance of the notation

The maintenance of the **STAR-MACH** notation is based on regular risk analysis reviews (see [3.2]) and the following surveys to be carried out by the Society, according to the scope and frequency given in [4]:

- annual audit at the Owner's offices (see [4.1])
- annual shipboard audit (see [4.2])
- occasional shipboard audits/surveys (see [4.3]) triggered by:
 - new risk analysis results
 - modifications to ship operations
 - non-conformities.

1.3 Ship database

1.3.1

The ship database is to be available on board and at the Owner's offices, in an electronic format suitable for consultation and analysis. It is to include at least the following information:

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

1.3.2 The ship database is to be:

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

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

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

1.3.3

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

2 Documentation to be submitted

2.1 Plans, documents and specifications

2.1.1

- a) The plans and documents necessary to assign the **STAR-MACH** notation are to include:
- the system machinery and equipment as per [1.1.3], if the risk analysis is performed by the Society
 - the maintenance plan of machinery / equipment of the selected systems, and

- information concerning the ship database and relevant electronic support to be implemented by the Owner during the ship life (see [1.3.1]);

- b) For a new ship, the plans and documents of the selected systems do not need to be duplicated with respect to those requested for the purpose of classification in Part C, Chapters 1, 2, 3 and 4.

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

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

In addition, if the risk analysis is performed by the Owner, he is to provide the Society with the risk analysis report, including the assumptions, considerations, risk models etc. that have brought to the resulting list of critical machinery/equipment of the selected systems, for approval.

2.2 Inclusion of the Risk Analysis in the PMS Manual

2.2.1

The structure of the PMS manual is to be in accordance with Ch 12, Sec 1, to which the risk analysis report (see [3] below) is to be added. The risk analysis report is to include at least:

- assumptions, considerations, risk models etc. that have led to the resulting list of critical machinery/equipment of the selected systems
- the risk reduction measures defined for the critical machinery/equipment (condition monitoring, additional surveys, etc.).

2.3 Changes to the Planned Maintenance

2.3.1 Changes to ship operation, condition monitoring, risk analysis review, or any other documented change may require modifications to the PMS. Where more defects are found than would be expected, it may be necessary to increase the extent and/or the frequency of the maintenance. The extent and/or the frequency of the maintenance may be varied upon consultation with the Manufacturer. In general, all modifications to the PMS are to be justified and documented, and are subject to approval by the Society.

2.4 Person responsible

2.4.1 The person on board responsible for the collection and processing of maintenance data within the scope of the planned maintenance is to be authorised by the Society in accordance with the procedure established for the recognition of machinery surveys carried out by Chief Engineers (see Pt A, Ch 2, App 1).

3 Risk analysis

3.1 Initial risk analysis

3.1.1 Purpose

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

- to identify critical items (equipment and/or components)
- to integrate the PMS with corrective/ preventive maintenance procedures for the critical items identified
- to recommend measures to improve the type and/or frequency of inspection and maintenance, when deemed necessary.

3.1.2 Process

The overall risk analysis process is described in App 6.

3.2 Risk analysis review

3.2.1 Scope

The initial risk analysis carried out in accordance with [3.1.1] is to be kept up-to-date by either the Society or the Owner upon agreement, on the basis of the information and data gathered from the ship database (see [1.3]), for instance results of inspection and maintenance tasks, failures and repairs.

The updated data may be used for a re-evaluation of the critical systems and components, if this proves to be necessary.

When the reviewed risk analysis shows a significant deviation of the items' criticality from the initial risk analysis, modifications of the Inspection and Maintenance Plan, for instance in terms of type and periodicity of maintenance, may be required, subject to approval by the Society.

3.2.2 Major alterations

In the case of major alterations to the machinery and equipment covered by the **STAR-MACH** notation, the risk model is to be updated to suit the new arrangements on board.

4 Maintenance of the notation

4.1 Annual audit at the Owner's offices

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

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

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

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

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

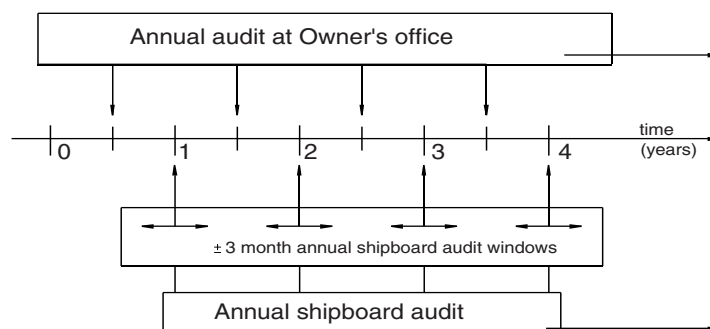
4.2 Annual shipboard audit

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

4.2.2 During this audit the Surveyor:

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

Figure 1



4.3 Occasional onboard audits and/or surveys

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

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

4.3.3 The Society is to be notified of changes to the operation of the ship and/or modifications to machinery and/or equipment to, so that:

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

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

4.4 Suspension and withdrawal of the notation

4.4.1 (1/7/2020)

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

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

4.4.2 (1/7/2020)

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

- a) The condition of the machinery installations is below the minimum level required for class. The action to be taken is either the immediate repair or the imposition of a condition of class (if acceptable) and suspension of the **STAR-MACH** notation. However, in cases where the condition of class is of a minor nature, the notation may not be suspended.
- b) The PMS is not complied with (e.g. delays in performing the operations scheduled according to the plan or the scope of inspection and/or maintenance is not completely fulfilled), and/or the maintenance of the database is not fulfilled.

The action to be taken is:

- either the immediate compliance with the requirements or the imposition of a condition of class, if the non-conformity is of a minor nature or is an exceptional occurrence, or
 - the suspension of the **STAR-MACH** notation, if the non-conformity is of a major nature or a recurrence.
- c) A defect or a deficiency is found in applying the PMS. The actions to be taken are the same as stated above both for repair of machinery installations (case a) above) and for the application of the PMS (case b)).
 - d) An unexpected defect or deficiency is found or a failure occurs, i.e. not as a result of lack of maintenance or failure in the application of the PMS. The actions to be taken are the same as stated in the case a) above.

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

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

APPENDIX 1

ACCEPTANCE CRITERIA FOR ISOLATED AREAS OF ITEMS

1 General

1.1 Application

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

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

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

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

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

Item		Acceptable limit	
		L < 90 m	L ≥ 90 m
Plating of: <ul style="list-style-type: none"> • keel, bottom and bilge • inner bottom • lower strake of inner side and longitudinal bulkheads • hopper tanks 		22%	18%
Longitudinal ordinary stiffeners of: <ul style="list-style-type: none"> • keel, bottom and bilge • inner bottom • lower strake of inner side and longitudinal bulkheads • hopper tanks 	Web	22%	18%
	Flange	18%	15%
Longitudinal primary supporting members	Web	22%	18%
	Flange	18%	15%

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

Item		Acceptable limit	
		L < 90 m	L ≥ 90 m
Plating of: <ul style="list-style-type: none"> • side • inner side and longitudinal bulkheads • 'tweendecks 		22%	18%
Longitudinals ordinary stiffeners of: <ul style="list-style-type: none"> • side • inner side and longitudinal bulkheads • 'tweendecks 	Web	22%	18%
	Flange	18%	15%
Longitudinal primary supporting members	Web	22%	18%
	Flange	18%	15%

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

Item	Acceptable limits		
	L < 90 m	L ≥ 90 m	
Plating of: <ul style="list-style-type: none"> upper deck, stinger plate and sheerstrake upper strake of inner side and longitudinal bulkheads side in way of topside tank topside tanks (lower horizontal part, sloping plate and upper vertical part) 	22%	18%	
Longitudinal ordinary stiffeners of: <ul style="list-style-type: none"> upper deck, stringer plate and sheerstrake upper strake of inner side and longitudinal bulkheads side in way of topside tank topside tanks (lower horizontal part, sloping plate and upper vertical part) 	Web	22%	18%
	Flange	18%	15%
Longitudinal primary supporting members	Web	22%	18%
	Flange	18%	15%

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

Item	Acceptable limit		
	L < 90 m	L ≥ 90 m	
Non-continuous hatch coamings	Plating	22%	18%
	Brackets	26%	22%
Hatch covers	Top plating	22%	18%
	Side and end plating	22%	18%
	Ordinary stiffeners	22%	18%
Plating of transverse bulkheads	22%	18%	
Ordinary stiffeners of transverse bulkheads	Web	26%	22%
	Flange	22%	18%
	Brackets	26%	22%
Vertical primary supporting members and horizontal girders of bulkheads	Web	22%	18%
	Flange	18%	15%
	Brackets /stiffeners	22%	18%
Side frames	Web	22%	18%
	Flange	18%	15%
	Brackets / stiffeners	22%	18%
Deck and bottom transverse primary supporting members	Web	22%	18%
	Flange	18%	15%
	Brackets	22%	18%
Topside tank and hopper tank primary supporting members	Web	22%	18%
	Flange	18%	15%
Plating of the forward and aft peak bulkheads	22%	18%	
Ordinary stiffeners of the forward and aft peak bulkheads	Web	26%	22%
	Flange	22%	18%
Cross ties	Web	22%	18%
	Flange	18%	15%
	Brackets /stiffeners	18%	15%

APPENDIX 2

ACCEPTANCE CRITERIA FOR ISOLATED ITEMS

Symbols

t_A	: As-built thickness of plating, in mm	$t_{M,F}$	: Measured thickness of ordinary stiffener face plate, in mm
t_M	: Measured thickness of plating, in mm	W_M	: Section modulus, in cm^3 , of ordinary stiffeners, to be calculated on the basis of the measured thicknesses of web, face plate and attached plating
t_C	: Corrosion additions, in mm, defined in Pt B, Ch 4, Sec 2, [3]	W_R	: Renewal section modulus, in cm^3 , of ordinary stiffeners i.e. the section modulus that an ordinary stiffener of a ship in service is to have to fulfil the yielding check.
t_{C1}, t_{C2}	: Corrosion additions, in mm, defined in Pt B, Ch 4, Sec 2, [3] for the two compartments separated by the plating under consideration. For plating internal to a compartment, $t_{C1} = t_{C2} = t_C$	$t_{R,W}$	: Renewal thickness, in mm, of ordinary stiffener web, i.e. the web thickness that an ordinary stiffener of a ship in service is to have in order to fulfil the buckling check. This thickness is to be calculated as specified in [3.2.2]
t_R	: Overall renewal thickness, in mm, of plating, in mm, defined in: <ul style="list-style-type: none"> • [2.2.1] in general • [4.3.1] for the plating which constitutes primary supporting members 	$t_{R,F}$	: Renewal thickness, in mm, of ordinary stiffener face plate, i.e. the face plate thickness that an ordinary stiffener of a ship in service is to have in order to fulfil the buckling check. This thickness is to be calculated as specified in [3.2.2]
t_{R1}	: Minimum renewal thickness, in mm, of plating defined in [2.2.2]	W_G	: Rule gross section modulus, in cm^3 , of ordinary stiffeners, defined in [3.2.3]
t_{R2}	: Renewal thickness, in mm, of plating subjected to lateral pressure or wheeled loads, i.e. the thickness that the plating of a ship in service is to have in order to fulfil the strength check. This thickness is to be calculated as specified in [2.2.3]	WR_R	: Re-assessment work ratio, defined in [4.2.1]
t_{R3}	: Compression buckling renewal thickness, in mm, i.e. the thickness that the plating of a ship in service is to have in order to fulfil the compression buckling check. This thickness is to be calculated as specified in [2.2.4]	WR_A	: As-built work ratio, defined in [4.2.2]
t_{R4}	: Shear buckling renewal thickness, in mm, i.e. the thickness that the plating of a ship in service is to have in order to fulfil the shear buckling check. This thickness is to be considered only for ships equal to or greater than 90 m in length and is to be calculated as specified in [2.2.5]	$t_{R,Y}$	: Yielding renewal thickness, in mm, of primary supporting members, i.e. the thickness that the plating which constitutes primary supporting members of a ship in service is to have in order to fulfil the yielding check. This thickness is to be calculated as specified in [4.3.2]
t_G	: Rule gross thickness, in mm, of plating, defined in [2.2.6]	$t_{R,B}$	: Buckling renewal thickness, in mm, of primary supporting members, i.e. the thickness that the plating which constitutes primary supporting members of a ship in service is to have in order to fulfil the buckling check. This thickness is to be calculated as specified in [4.3.3]
$t_{A,W}$	: As built thickness of ordinary stiffener web, in mm	E	: Young's modulus, in N/mm^2 , to be taken equal to: <ul style="list-style-type: none"> • for steels in general: $E = 2,06 \cdot 10^5 \text{ N/mm}^2$ • for stainless steels: $E = 1,93 \cdot 10^5 \text{ N/mm}^2$
$t_{A,F}$	: As built thickness of ordinary stiffener face plate, in mm		
$t_{M,W}$	: Measured thickness of ordinary stiffener web, in mm		

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

R_{eH} : Minimum yield stress, in N/mm², of the material, defined in Pt B, Ch 4, Sec 1, [2]

$\gamma_m, \gamma_R, \gamma_{K1}, \dots, \gamma_{K9}$: Partial safety factors, defined in [1].

1 Partial safety factors

1.1 General

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

- Pt B, Ch 7, Sec 1, [1.2] or Pt B, Ch 8, Sec 3, [1.3], as applicable, for plating
- Pt B, Ch 7, Sec 2, [1.2] or Pt B, Ch 8, Sec 4, [1.3], as applicable, for ordinary stiffeners
- Pt B, Ch 7, Sec 3, [1.3] or Pt B, Ch 8, Sec 5, [1.3], as applicable, for primary supporting members.

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

1.2.1 General

The partial safety factors $\gamma_{K1}, \gamma_{K2}, \dots, \gamma_{K9}$ take into account the increased knowledge of the structural behaviour obtained through the surveys carried out on in-service ship structures and verification of their performances. Therefore, they have values equal to or less than 1,0 and apply to reduce the partial safety factor on resistance, γ_R , adopted in the strength checks of new ships (see Part B, Chapter 7 or Part B, Chapter 8, as applicable).

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

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

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

1.2.3 Partial safety factor γ_{K5} for ordinary stiffeners

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

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

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

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

2 Acceptance criteria for plating

2.1 Application

2.1.1 General

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

2.1.2 Specific cases

For the specific cases indicated in Tab 1, the acceptance criteria to be applied, in lieu of those in [2.1.1], are those specified in the Rules to which reference is made in the same table. In these cases, the maximum wastage allowances are 0,75 times the values there specified.

2.2 Renewal thicknesses

2.2.1 Overall renewal thickness

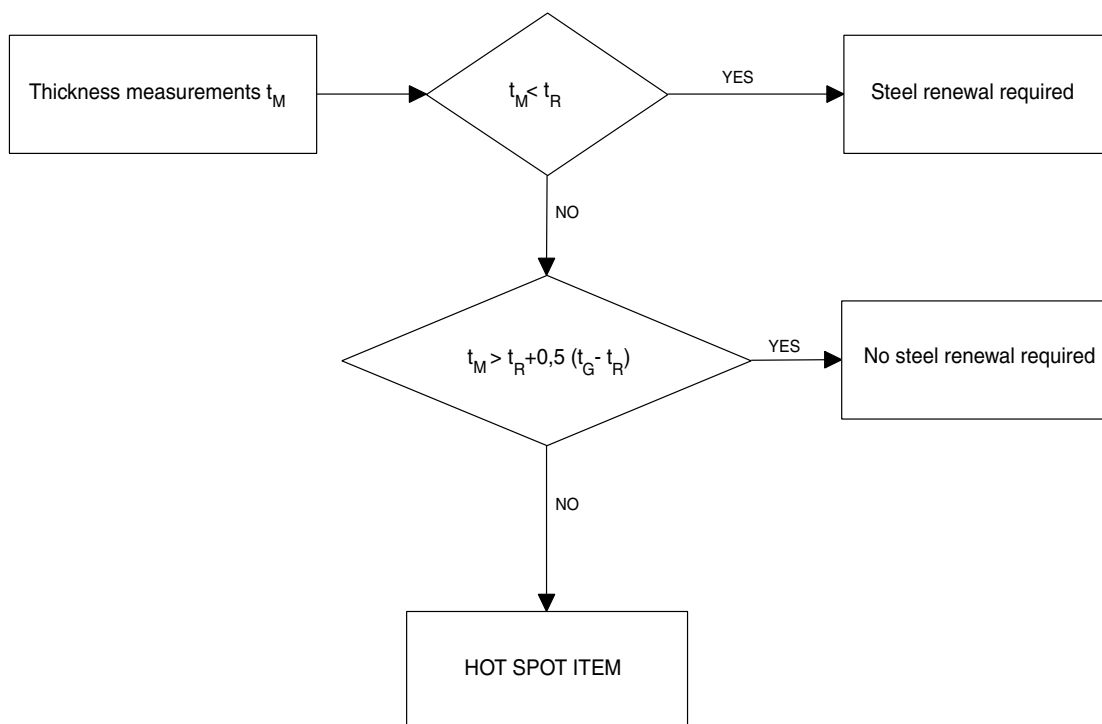
The overall renewal thickness is to be obtained, in mm, from the following formula:

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

Table 1 : Acceptance criteria to be applied in specific cases

Ship type	Item	Rules to be applied
Ships with the service notation bulk carrier ESP , of single side skin construction, having $L \geq 150$ m, intended for the carriage of bulk cargoes having dry bulk density equal to or greater than 1,0 t/m ³ , contracted for construction on or after 1 July 1998	Plating of vertically corrugated transverse watertight bulkheads	Part A
Ships with the service notation bulk carrier ESP , contracted for construction on or after 1 July 1998	Hatch cover plating	Part A
Ships with the service notation bulk carrier ESP , of single side skin construction, having $L \geq 150$ m, intended for the carriage of bulk cargoes having dry bulk density equal to or greater than 1,78 t/m ³ , contracted for construction prior to 1 July 1998	Plating of vertically corrugated transverse watertight bulkhead between cargo holds No. 1 and 2	Pt A, Ch 6, App 1

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



2.2.2 Minimum renewal thickness

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

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

where:

t_1 : Minimum net thickness, in mm, to be calculated as specified in Pt B, Ch 7, Sec 1, [2.2] or Pt B, Ch 8, Sec 3, [2.2], as applicable

γ_{K1} : Partial safety factor (see [1.2.2]):

$$\gamma_{K1} = N_p \Psi_1$$

without being taken greater than 1,0

N_p : Coefficient defined in Tab 2

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

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

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

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

where:

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

- Pt B, Ch 7, Sec 1, [3] or Pt B, Ch 8, Sec 3, [3], as applicable, for plating subjected to lateral pressure
- Pt B, Ch 7, Sec 1, [4] or Pt B, Ch 8, Sec 3, [4], as applicable, for plating subjected to wheeled loads

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

γ_{K2} : Partial safety factor (see [1.2.2]):

$$\gamma_{K2} = N_p \Psi_2$$

without being taken greater than 1,0

N_p : Coefficient defined in Tab 2

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

2.2.4 Compression buckling renewal thickness

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

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

where:

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

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

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

b : Length, in m, of the plate panel side, defined in Pt B, Ch 7, Sec 1, [5.1.2] or Pt B, Ch 8, Sec 3, [5.1.2], as applicable

Table 2 : Coefficient N_p

Plating	Coefficient N_p	
	L < 90 m	L ≥ 90 m
In general, including that which constitutes web of primary supporting members	0,81	0,85
Plating which constitutes face plate of primary supporting members	0,85	0,89
Bottom primary supporting members of ships with one of the service notations bulk carrier ESP, ore carrier ESP and combination carrier ESP	0,85	0,89
Hatch coaming brackets	0,78	0,81
Cross ties of ships with the service notation oil tanker ESP	0,85	0,89

σ_{x1} : In plane hull girder normal stress, in N/mm² to be calculated as specified in Pt B, Ch 7, Sec 1, [5.2.2] or Pt B, Ch 8, Sec 3, [5.2.2], as applicable, considering the hull girder transverse sections as being constituted by elements (plating, ordinary stiffeners, primary supporting members) having their measured thicknesses and scantlings

ϵ, K_1 : Coefficients defined in Pt B, Ch 7, Sec 1, [5.3.1] or Pt B, Ch 8, Sec 3, [5.3.1], as applicable

γ_{K3} : Partial safety factor (see [1.2.2]):

$$\gamma_{K3} = N_p \Psi_3$$

without being taken greater than 1,0

N_p : Coefficient defined in Tab 2

$$\Psi_3 = 1 + \frac{t_{c1} + t_{c2}}{t_3}$$

2.2.5 Shear buckling renewal thickness

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

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

where:

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

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

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

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

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

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

γ_{K4} : Partial safety factor (see [1.2.2]):

$$\gamma_{K4} = N_p \Psi_4$$

without being taken greater than 1,0

N_p : Coefficient defined in Tab 2

$$\Psi_4 = 1 + \frac{t_{c1} + t_{c2}}{t_4}$$

2.2.6 Rule gross thickness

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

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

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

3 Acceptance criteria for ordinary stiffeners

3.1 Application

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

3.2 Renewal scantlings

3.2.1 Renewal section modulus

The renewal section modulus is to be obtained, in cm³, from the following formula:

$$W_R = W_Y \gamma_{K5}$$

where:

W_Y : Net section modulus, in cm³, to be calculated as specified in Pt B, Ch 7, Sec 2, [3] or Pt B, Ch 8, Sec 4, [3], as applicable, where the hull girder stresses are to be calculated considering the hull girder transverse sections constituted by elements (plating, ordinary stiffeners, primary supporting members) having their measured thicknesses and scantlings

γ_{K5} : Partial safety factor (see [1.2.3]):

$$\gamma_{K5} = N_S \Psi_5$$

without being taken greater than 1,0

N_S : Coefficient defined in Tab 3

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

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

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

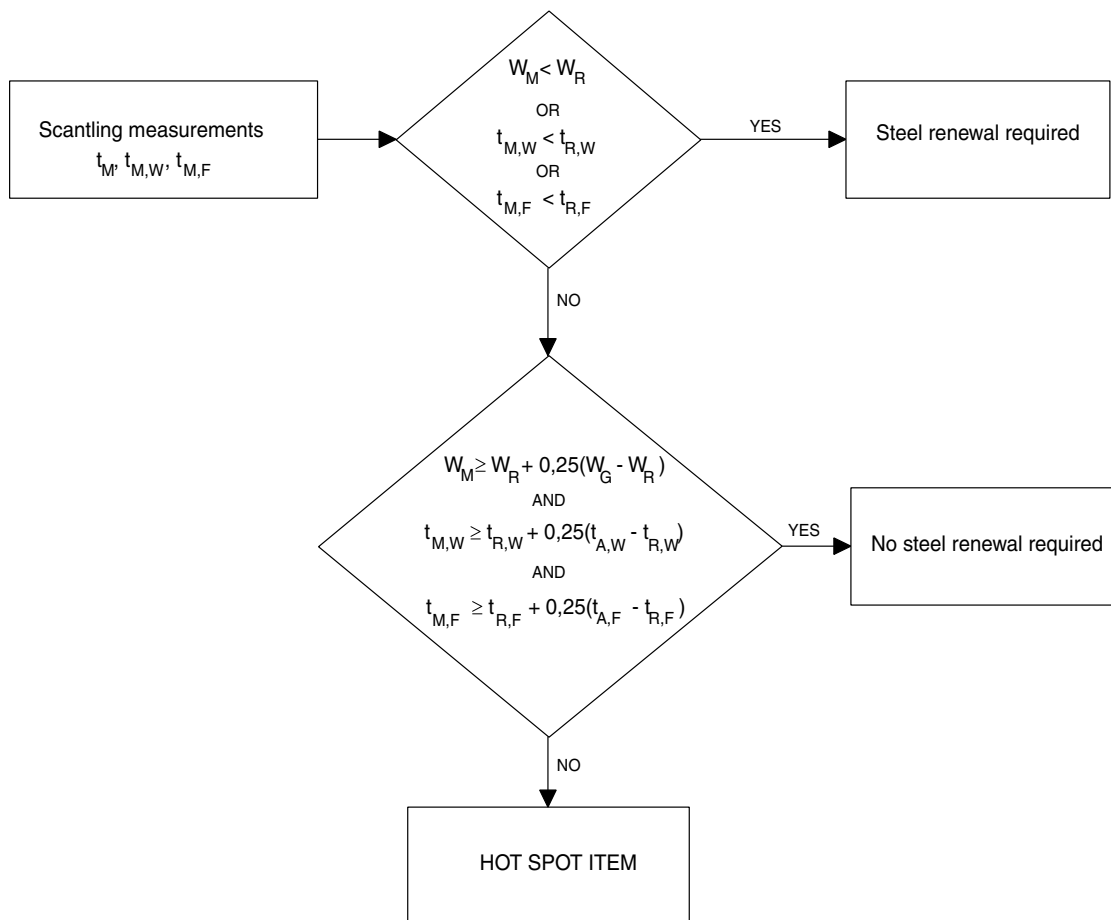


Table 3 : Coefficient N_s

Ordinary stiffeners	Coefficient N _s	
	L < 90 m	L ≥ 90 m
Flat bars and bulb profiles	0,81	0,85
Flanged profiles	0,81	0,81

3.2.2 Renewal web and face plate thicknesses

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

$$t_{R,W} = h_w / C_w$$

$$t_{R,F} = b_f / C_f$$

where:

h_w : Web height, in mm

b_f : Face plate breadth, in mm

C_w, C_f : Coefficients depending on the type and material of ordinary stiffeners, defined in Tab 4.

In any case, the renewal web and face plate thicknesses are to be not less than those obtained according to Pt A, Ch 2,

App 2, [4], considering a maximum percentage of wastage equal to 0,75 times the relevant values there specified.

3.2.3 Rule gross section modulus

The rule gross section modulus is to be obtained, in cm³, from the following formula:

$$w_G = \frac{w_y + \beta t_c}{1 - \alpha t_c}$$

where:

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

w_y : Net section modulus, in cm³, defined in [3.2.1].

4 Acceptance criteria for primary supporting members

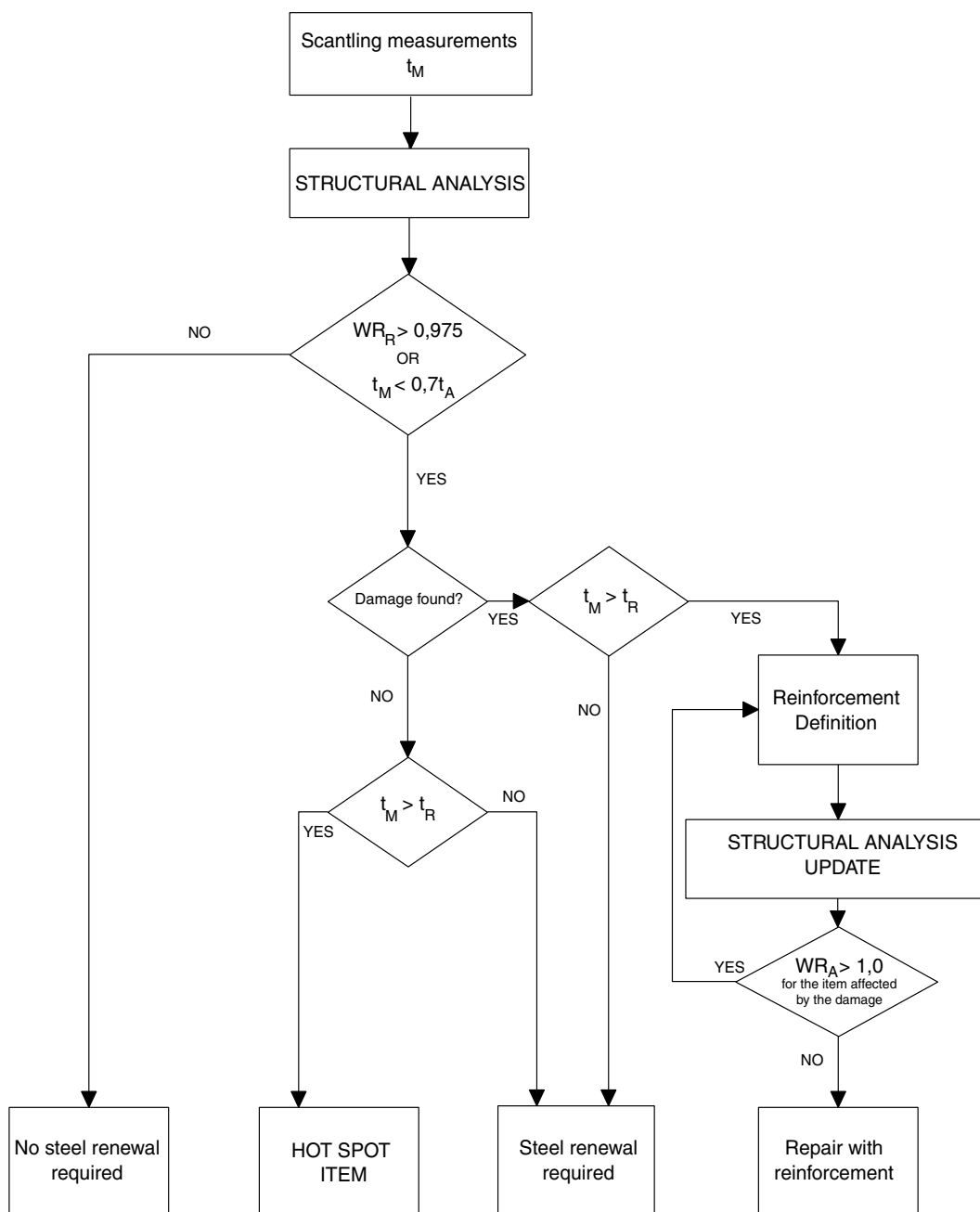
4.1 Application

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

Table 4 : Coefficients C_W and C_F

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

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



4.2 Work ratios

4.2.1 Reassessment work ratio

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

$$WR_R = \max(\gamma_{k6} WR_Y, \gamma_{k7} WR_B)$$

where:

γ_{k6} : Partial safety factor (see [1.2.4]):

$$\gamma_{k6} = 0,85$$

γ_{k7} : Partial safety factor (see [1.2.4]):

$$\gamma_{k7} = 1,00$$

WR_Y : Yielding work ratio, defined in [4.2.3]

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

4.2.2 As-built work ratio

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

$$WR_A = \max(WR_Y, WR_B)$$

where:

WR_Y : Yielding work ratio, defined in [4.2.3]

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

4.2.3 Yielding work ratio

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

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

where:

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

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

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

4.2.4 Buckling work ratio

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

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

where:

WR_{B1} : Compression buckling work ratio:

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

WR_{B2} : Shear buckling work ratio:

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

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

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

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

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

$\sigma_a, \sigma_b, \tau_b$: Normal and shear stresses, in N/mm², defined in Pt B, Ch 7, Sec 1, [5.4]

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

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

F_c : Coefficient to be obtained from the following formula:

$$\text{for } \frac{\sigma_{comb}}{F} \leq \frac{R_{eH}}{2\gamma_R \gamma_m} :$$

$$F_c = 1$$

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

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

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

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

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

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

4.3 Renewal scantlings

4.3.1 Overall renewal thickness

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

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

4.3.2 Yielding renewal thickness

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

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

where:

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

$$t_Y = [t_A - 0,5 (t_{C1} + t_{C2})] WR_Y$$

WR_Y : Yielding work ratio, defined in [4.2.3]

γ_{K8} : Partial safety factor (see [1.2.4]):

$$\gamma_{K8} = N_p \Psi_Y$$

N_p : Coefficient defined in Tab 2

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

4.3.3 Buckling renewal thickness

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

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

where:

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

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

WR_B : Buckling work ratio, defined in [4.2.4]

γ_{K9} : Partial safety factor (see [1.2.4]):

$$\gamma_{K9} = N_p \Psi_B$$

N_p : Coefficient defined in Tab 2

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

APPENDIX 3

ACCEPTANCE CRITERIA FOR ZONES

1 General

1.1 Application

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

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

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

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

APPENDIX 4 PITTING INTENSITY DIAGRAMS

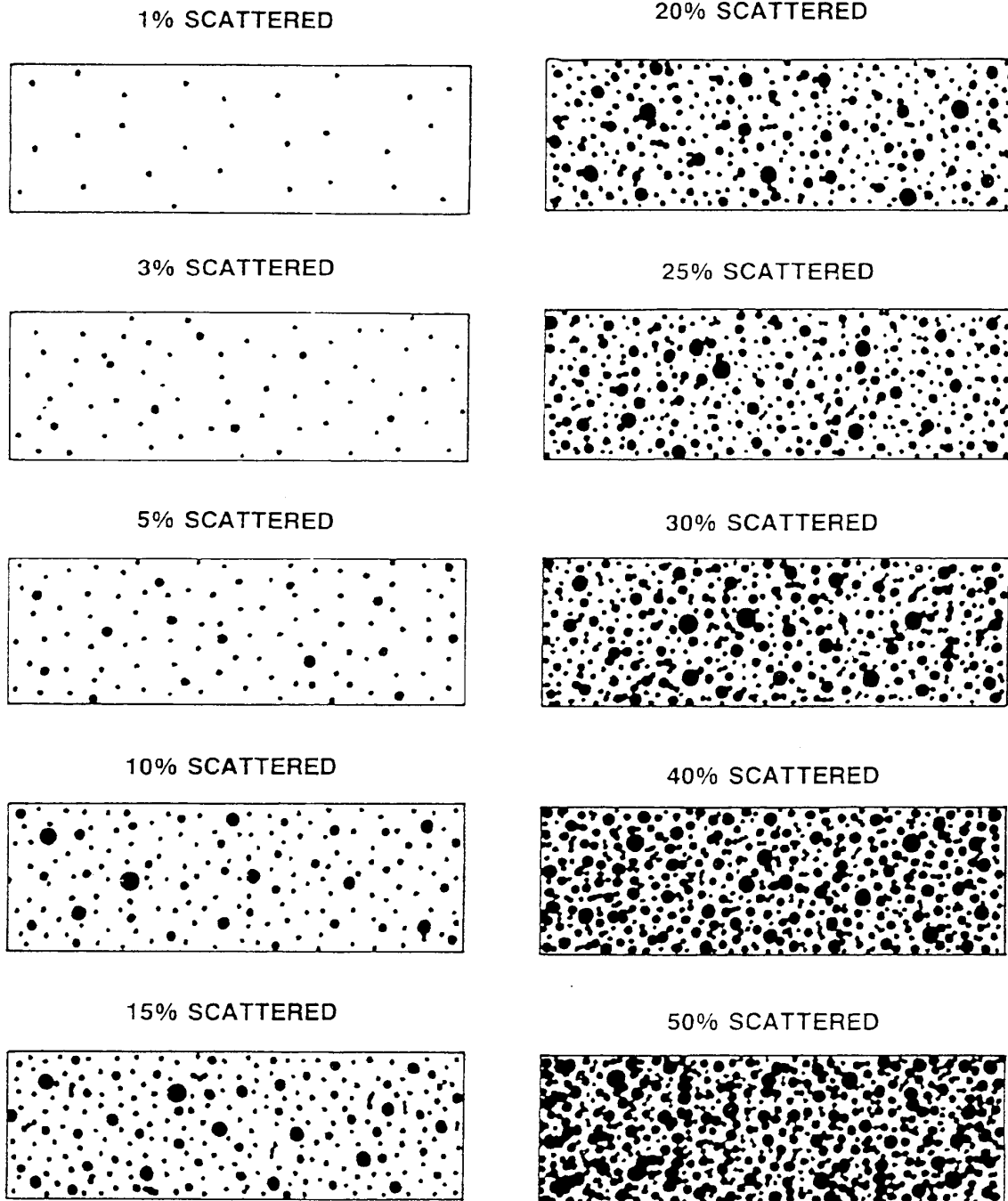
1 General

In order to define the area affected by pitting, and thus the pitting intensity, the diagrams in Fig 1 are to be used.

1.1 Diagrams

1.1.1 As specified in Sec 1, [4.4.1], the pitting intensity is defined by the percentage of area affected by pitting.

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



APPENDIX 5

OWNER'S HULL INSPECTION REPORTS

1 General

1.1

1.1.1 Application

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

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

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

1.1.2 Use of models

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

1.1.3 Ship database

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

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

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

2 Report for inspection of spaces

2.1 General

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

2.1.2 The report is divided into four parts:

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

2.2 Identification data

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

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

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

2.3 Summary of findings and repairs

2.3.1 Each space inspected is divided into items corresponding to:

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

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

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

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

Table 1 : Owner's report for space inspection

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

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

Findings during inspection: (location, type, details)	Action taken: required repair, temporary repair, permanent repair (location, type and extent)

Other documentation attached to the report :
 sketches [], photos [], thickness measurement report [], other []

2.4 Details of findings and repairs

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

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

- for coating found in poor condition: structural elements concerned, type of coating defect (breakdown, hard scale)
- for fractures: location of fractures, dimension, number of identical fractures
- for general corrosion: structural elements concerned, extent of wastage on these elements, estimation of wastage (if thickness measurements have been taken)
- for pitting/grooving: structural elements concerned and location, depth of pitting/grooving, percentage of affected surface using diagrams in Appendix 5, length of grooving
- for deformations: type of deformation (buckling, external cause), location of the deformation and structural elements concerned, estimation of size
- for repairs (if performed without the attendance of a Surveyor, when this is possible or acceptable): type of repairs, elements or areas concerned.

2.5 Attached documentation

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

For example:

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

3 Report for inspection of equipment

3.1 General

3.1.1 The model of Owner’s report for equipment inspection is given in Tab 2.

3.1.2 The report is divided into three parts:

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

3.2 Identification data

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

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

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

3.3 Detailed report

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

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

3.4 Attached documentation

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

For example:

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

Table 2 : Owner’s report for equipment inspection

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

Type of inspection, findings and readings:

Repairs, maintenance, pieces renewed:

Working tests, pressure test, trials, ... :

Other documentation attached to the report :
 sketches [], photos [], thickness measurement report [], other []

APPENDIX 6

RISK ANALYSIS FOR STAR-MACH

1 General

1.1 Application

1.1.1 Purpose

The purpose of this Appendix is to describe the procedure foreseen to carry out the risk analysis, in order to assign and maintain the **STAR-MACH** notation, as given in Sec 2.

The aim of the risk analysis is to identify critical systems and/or components, to be included in the Inspection and Maintenance Plan together with the measures to reduce their risk.

1.2 Risk analysis process

1.2.1 Initial risk analysis

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

1.2.2 Risk analysis review

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

1.3 Procedure

1.3.1 Definitions

- a) Accident is defined as an event or a series of events whose consequence is loss of life, injury, ship loss or damage, or environmental damage.
- b) Risk is defined as the combination of the probability and consequence of an accident.
- c) Critical is a system and/or component whose failure may affect an essential ship's function (e.g. main propulsion system).
- d) Fault Tree (FT) is a logic diagram in which an undesired event ('top event') is considered and its causes are developed, where: the relationships among the lower level events (generally failures) are established by means of logic gates (the principal ones being AND and OR). The result is a set of combinations of events (generally failures), each of which is necessary and sufficient to cause the top event. The FT may be qualitative or quantitative, according to whether statistical data are associated to each event.
- e) Failure Mode and Effect Analysis (FMEA) is a technique to analyse the modes and consequences of a single failure of a component in a system. The effects of each single failure are analysed to determine their severity and possible mitigation with respect to the loss of the system as a whole.

2 Overall process

2.1 Selection of the ship's critical systems

2.1.1

The risk analysis (Sec 2, [1.1.3]) is to include at least the machinery and equipment belonging to the following systems:

- Propulsion
- Electrical Production
- Steering gear,

including the auxiliaries that are essential for the functionality of the aforesaid systems.

Upon agreement with the Owner, the scope of the risk analysis may be extended to other equipment or systems which are considered critical, depending on the declared mission of the ship.

2.2 Risk analysis of the systems

2.2.1

The selected critical systems and components are to be analysed taking into account their functions in normal and emergency operations.

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

In principle, any of the standard methods for performing the risk analysis can be used (e.g. FMEA, Fault Tree Analysis etc.); the choice depends on the degree of complexity of the system. For systems characterised by high level of redundancy, the Fault Tree analysis (or any other equivalent method) is recommended; systems with components that operate in functional series can be studied by the FMEA; particularly simple systems may need only qualitative considerations from the examination of their drawings and layout. In any case, the process used, the assumptions and the results are to be clearly justified and documented in a dedicated report.

2.3 Identification of the critical items to be monitored

2.3.1

The critical items to be monitored during the ship life are those which appear from the risk analysis to have the largest

influence on the risks, with particular focus on the potential single failures affecting a system under study.

The items will be subjected to the process shown in Fig 1, and the resulting actions are to be implemented in the IMP.

2.4 Collection of actual failure and maintenance data

2.4.1

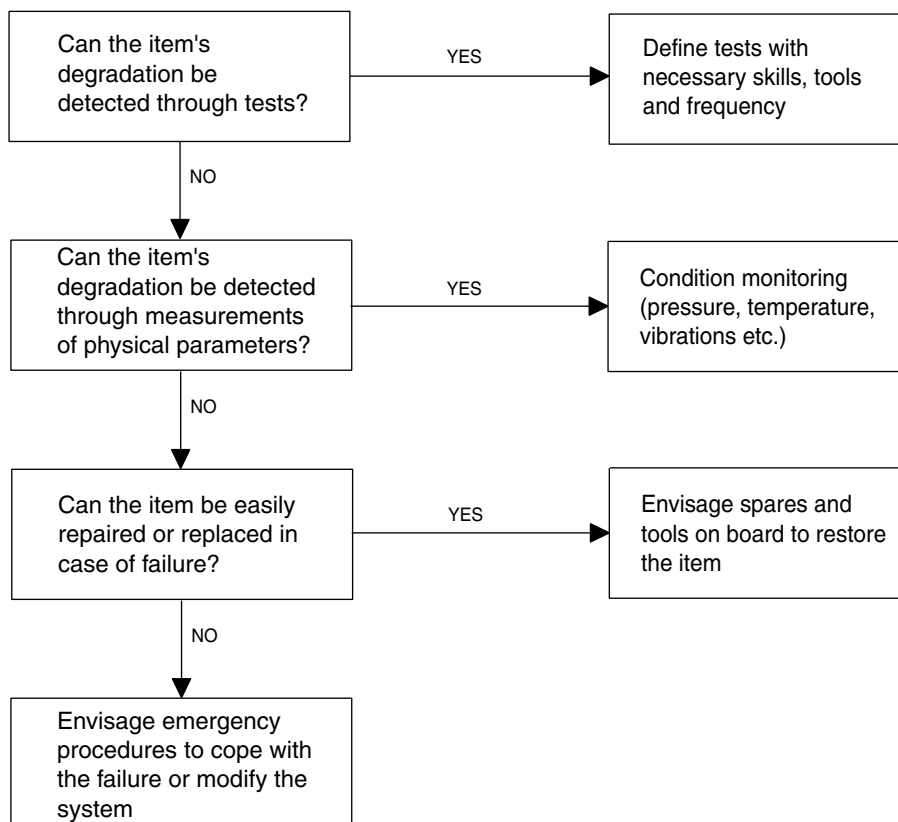
The actual information and data relative to preventive and corrective maintenance and inspection on board for the items found to be critical from the risk analysis are downloaded from the ship database at the request of the Society. In particular, the following data may be requested:

- working hours of each component
- mode, cause and time of failure

- down time induced by the failure
- schedule, timing and resources (manpower and consumables) foreseen for the preventive maintenance
- details on corrective maintenance (spare parts used, tasks carried out, mean time between two corrective actions)
- date when the component was replaced or reconditioned.

Whenever practicable, the actual information and data mentioned above may be transformed into statistical parameters to be periodically updated, for comparison with similar equipment, analysis of reliability trends, optimisation of the replacement intervals, etc.; these further analyses may lead to modification of the frequency of the Inspection and Maintenance Plan.

Figure 1



Part F
Additional Class Notations

Chapter 2

AVAILABILITY OF MACHINERY (AVM)

- SECTION 1 ALTERNATIVE PROPULSION SYSTEM (AVM-APS)**
- SECTION 2 INDEPENDENT ALTERNATIVE PROPULSION
SYSTEM (AVM-IAPS)**
- SECTION 3 DUPLICATED PROPULSION SYSTEM
(AVM-DPS)**
- SECTION 4 INDEPENDENT PROPULSION SYSTEM
(AVM-IPS)**
- APPENDIX 1 PROCEDURES FOR FAILURE MODE AND EFFECT ANALYSIS**

SECTION 1

ALTERNATIVE PROPULSION SYSTEM (AVM-APS)

1 General

1.1 Application

1.1.1

The additional class notations **AVM-APS** or **AVM-APS-NS** are assigned in accordance with Pt A, Ch 1, Sec 2, [6.3.2] to self propelled ships arranged with means for alternative propulsion system complying with the requirements of this Section.

1.1.2

The alternative propulsion system is a system suitable to maintain the ship propulsion in operating conditions, with the limitations as specified below.

1.1.3

When the alternative propulsion system is designed for emergency use only, in case of loss of the main propulsion engine, the additional class notation **AVM-APS** is assigned.

1.1.4

When the auxiliary propulsion system is designed for use in conditions other than an emergency, the additional class notation **AVM-APS-NS** is assigned.

1.2 Coverage of AVM-APS and AVM-APS-NS notations

1.2.1 Single failure concept

- a) Any single failure leading to the loss of main engine is considered.
- b) The following items do not need to be considered for the purpose of granting the **AVM-APS** or **AVM-APS-NS** notations:
 - Rigidly coupled shafting components (i.e. propeller, propeller shaft, intermediate shafts, bearings, couplings, reduction gears)
 - Static components of the systems which are necessary for the operation of the main engine (i.e. integrity of pipes, valves, pipe fittings, pipe supports, tanks)
 - Loss of one compartment due to fire or flooding.
- c) In principle, consequence failures, i.e. any failure of any component directly caused by a single failure of another component, are also to be considered.

It is however assumed that the complete loss of the main propulsion engine does not impair the proper functioning of the other machinery and equipment.

1.2.2 Targets

The following operating conditions are to be achieved by ships having an alternative propulsion system in the event of any single failure, as specified in [1.2.1]:

- Full load speed not less than 7 knots
- Range of 1000 nautical miles or range corresponding to 1/2 of the range achievable with the full supply of fuel, whichever is the less
- Full steering capability
- Availability of safety systems (including fire fighting systems, bilge system, navigating lights, communication apparatus, life-saving appliances)
- Habitability conditions (including minimum lighting, ventilation, galleys, refrigerated stores, drinking water or evaporator services)
- Preservation of the cargo (when **AVM-APS-NS** notation is assigned).

1.2.3 Services not required to be available

The following services need not to be supplied during the operation of the alternative propulsion system:

- Cargo handling system
- Ballast system needed for cargo handling operation only
- Bow thrusters
- Air conditioning
- Other non essential services (for instance stabilizers, full lighting, amusement items).

1.3 Redundancy

1.3.1

When the alternative propulsion system is designed for emergency use only (e.g. unavailability of the main engine caused by a single failure), for the purpose of granting the **AVM-APS** notation the following applies:

- a) it is accepted that some of the redundancies of machinery and system normally required by the Rules may no longer be available
- b) when exemptions are foreseen by the Rules for multiple propulsion systems, they are still applicable.

1.3.2

When the alternative propulsion system is designed for use in conditions other than an emergency, for the purpose of granting the **AVM-APS-NS** notation the following applies:

- a) all the redundancies of machinery and system normally required by the Rules are to be kept available, except the redundancy of the exciters, in the event of use of a synchronous machine as source of alternative propulsion power;
- b) the exemptions mentioned in item [1.3.1] b) are no longer applicable.

1.4 Documentation to be submitted

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

2 Special arrangements

2.1 Propulsion system

2.1.1 Alternative propulsion machinery

For ships having only one main engine and one propeller, the alternative propulsion power is to be supplied either by an alternative engine or electric motor, or by the shaft generators, provided it has been designed in such a way that it can be readily used as propulsion motor in the case of loss of the main engine.

2.1.2 Coupling

Each engine or motor is to be able to be coupled/uncoupled (as needed) to the shafting with an independent, effective, readily usable means.

2.2 Systems for cooling, lubrication, fuel supply and starting

2.2.1 General

The systems are to be constructed such as to satisfy the conditions stipulated in [1.2.2]. In addition to what stated in the relevant parts of the Rules, the following requirements apply.

2.2.2 Pumps

For the assignment of the **AVM-APS** notation, the systems concerned are to be provided with at least two pumps, one as a stand-by of the other. The independently driven pumps of the main engine may be used if they are of adequate characteristics.

For the assignment of the **AVM-APS-NS** notation, the systems concerned are to be provided with at least two pumps,

one as a standby for the other also in case of unavailability of the main engine.

2.2.3 Cooling system

The circuit for the main engine may be used provided that proper operation is ensured where the part relative to the main engine itself is cut off.

2.2.4 Lubrication system

The circuit or circuits of the components of the alternative propulsion system is/are to be independent of that for the main engine.

2.2.5 Fuel oil system

The circuit for the main engine may be used provided that proper operation is ensured where the part relative to the main engine itself is cut off.

2.2.6 Starting system

The circuit for the main engine may be used provided that proper operation is ensured where the part relative to the main engine itself is cut off.

2.3 Electrical installations

2.3.1 Alternative propulsion system designed for emergency use only (AVM-APS notation)

When the alternative propulsion system is designed for emergency use only (**AVM-APS** notation) and is supplied by the main source of electrical power, the capacity of the main generating sets is to be sufficient to comply with the requirements of Pt C, Ch 2, Sec 3, [2.2], and to start and operate the alternative propulsion system taking into account the following modifications:

- a) it is not required that the available power is sufficient to supply those services necessary to provide preservation of the cargo and those services indicated in [1.2.3],
- b) it is not required that the power to start and operate the alternative propulsion system is available with any one of the main generating sets in standby condition.

Table 1 : Document to be submitted

No.	(1)	Document
1	A	Description of the alternative propulsion system including an analysis (2) demonstrating the availability of the operating conditions as per [1.2.2] and a description of the operations necessary to recover the propulsion and essential services
<p>(1) A : to be submitted for approval, in four copies;</p> <p>(2) This analysis may be in the form of a Failure Mode and Effect Analysis (FMEA), unless the actual arrangement of the machinery and equipment is quite simple and sufficient operating experience can be demonstrated such as to make unlikely the possibility of consequence failure in the case of a single failure. In such a case the Society may consider to accept a functional description of system in lieu of the requested analysis.</p>		

2.3.2 Alternative propulsion system designed for use in conditions other than an emergency (AVM-APS-NS notation)

When the auxiliary propulsion system is designed for use in conditions other than an emergency (AVM-APS-NS notation) and is supplied by the main source of electrical power, the capacity of the main generating sets is to be sufficient to comply with the requirements of Pt C, Ch 2, Sec 3, [2.2], and to start and operate the alternative propulsion system with any one of the generating sets in standby condition.

Consequently, it is required that the above available power is also sufficient to supply those services necessary to provide preservation of the cargo while it is still not required that the available power is sufficient to supply those services indicated in [1.2.2].

2.4 Automation

2.4.1

- a) The alternative propulsion system is to be integrated with any automation system installed on board.
- b) Where the alternative propulsion system is electric, the automation system is to be suitable for electric propulsion.

3 Tests on board

3.1 Running tests

3.1.1 The alternative propulsion system is to be subjected to the running tests required by the Rules for similar systems.

3.2 Sea trials

3.2.1

In the course of sea trials, the single failures mentioned in [1.2.1] are to be simulated and the values of the power and speed developed by the alternative propulsion system are to be recorded.

Availability of the redundancies as per [1.3] is to be verified.

SECTION 2

INDEPENDENT ALTERNATIVE PROPULSION SYSTEM (AVM-IAPS)

1 General

1.1 Application

1.1.1

The additional class notation **AVM-IAPS** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.3.3] to self-propelled ships arranged with means for independent alternative propulsion complying with the requirements of this Section.

1.1.2

This notation is granted, provided that:

- a) the ship is arranged with at least two propellers and the associated independent shafting, each one independently driven by separate machinery, in such a way that the propulsion power needed to comply with [1.2] remains available whenever any of the propulsion machinery and the associated propeller and shafting are out of service.

It is also applicable to ships arranged with at least two independent azimuth thrusters and any other equivalent arrangement;

- b) the propulsive installations are arranged in different compartments, in such a way that the propulsion power needed to comply with [1.2] remains available whenever propulsion and auxiliary machinery arranged in any one compartment is not operating.

1.2 Coverage of AVM-IAPS notation

1.2.1 Casualty

The loss (due to fire or flooding) of one compartment where propulsion, its auxiliary machinery, and the main source of electrical power are located is to be considered.

However, the collision in way of a bulkhead and the consequent loss of two adjacent compartments due to flooding is not to be considered a casualty for the purpose of this additional class notation.

The loss of the steering gear compartment is not considered within the scope of this additional class notation.

1.2.2 Targets

The following operating conditions are to be achieved by ships having an independent alternative propulsion system, in the case of a casualty, as specified in [1.2.1]:

- Full load speed not less than 7 knots (lower speeds may be considered acceptable when the ship is provided with azimuth thrusters or similar propulsion thrusters)
- Range of 1000 nautical miles or range corresponding to 1/2 of the range achievable with the full supply of fuel, whichever is the lesser

- Steering capability
- Availability of safety systems, including fire-fighting systems, bilge system, navigation lights, communication apparatus, life-saving appliances
- Habitability conditions, including minimum lighting, ventilation, galleys, refrigerated stores, drinking water or evaporator services
- Preservation of the cargo.

1.2.3 Services not required to be available

The following services need not be supplied after a casualty, during the emergency operation of the independent alternative propulsion system, when one of the propulsion systems is not available due to the casualty described in [1.2.1]:

- Cargo handling system
- Ballast system needed for cargo handling operation only
- Bow thrusters
- Air conditioning
- Other non essential services (for instance stabilisers, full lighting, amusement items).

1.2.4 Redundancy

If the independent alternative propulsion system is used in an emergency due to the loss of one compartment, it is accepted that some of the redundancies normally required by the Rules may no longer be available.

However, in the case of unavailability of one of the propulsion systems due to a single failure (excluding the loss of one compartment), all the redundancies of machinery and systems normally required by the Rules are to be kept available.

In the case of electric propulsion, cold standby propulsion control systems may be accepted in way of full redundancy provided that they are permanently installed, ready for use and easily put into operation.

1.3 Documentation to be submitted

1.3.1

The documents listed in Tab 1 are to be submitted.

2 Special arrangements

2.1 Systems for cooling, lubrication, fuel supply and starting

2.1.1 General

The (main and alternative) propulsion systems, the propulsion auxiliaries and the main source of electrical power are

to be designed and constructed such as to satisfy the conditions stipulated in [1.2.2].

In addition to the provisions in the relevant parts of the Rules and in [1.2.4], the following requirements apply.

2.1.2 Pumps

The systems concerned are to be provided with at least two pumps, one as a standby for the other, suitably located so that in the case of loss of one compartment at least one is still available.

One of the two pumps may be driven by the propulsion machinery, while the other is to be independently driven.

2.1.3 Cooling system

In general, separate cooling systems are to be provided for each main propulsion system, unless the FMEA demonstrates that one single cooling system serving all propulsion systems is arranged and located in such a way that any single failure of the system, including loss of one compartment, does not make all the propulsion systems inoperative at the same time.

2.1.4 Lubricating oil system

Each main propulsion system is to be fitted with a separate lubrication oil system.

2.1.5 Fuel oil system

In general, separate fuel oil systems are to be provided for each main propulsion system, unless the FMEA demonstrates that one single fuel oil system serving all propulsion systems is arranged and located in such a way that any single failure of the system, including loss of one compartment, does not make all the propulsion systems inoperative at the same time.

2.1.6 By-pass

Means are to be provided to bypass and shut off each of the components which may be subject to single failure or malfunction due to the casualty, as described in [1.2.1], without impairing the functioning of the system itself (including machinery and equipment) or of the other systems which are to be operated in connection with alternative propulsion.

2.1.7 Piping segregation

Piping systems common to the main and alternative propulsion systems or piping systems serving one propulsion system and passing through the spaces where another independent propulsion system is arranged are to be ducted in watertight trunks having a fire-retardant resistance at least equivalent to A60 standard and located outside B/5.

The trunks are to be accessible for inspection and maintenance.

2.2 Electrical installations

2.2.1

The electric generators are to be arranged in such a way that in the event of loss of one compartment, enough power still remains available to operate the ship under the conditions stated in [1.2.2] without any standby generating set. In general, this requirement is to be achieved arranging two main switchboards and the electric generators in two separate compartments.

2.2.2

Electrical cables and other electrical apparatus serving a machinery space and passing through the spaces where the other independent propulsion system is arranged are to be ducted in trunks having a fire-retardant resistance at least equivalent to A60 Standard and located outside B/5.

The trunks are to be accessible for inspection and maintenance.

The use of fire-resisting cables, as an alternative to the trunks having a fire-retardant resistance at least equivalent to A60 standard, will be considered on a case-by-case basis.

2.3 Automation

2.3.1

The automation system is to be arranged in such a way as to prevent the possibility that a single failure of the control system may lead to the loss of more than one propulsion system.

In the case of electric propulsion, cold standby propulsion control systems may be accepted in way of full redundancy provided that they are permanently installed, ready for use and easily put into operation.

3 Tests on board

3.1 Running tests

3.1.1

The independent alternative propulsion system is to be subjected to the running tests required by the Rules for similar systems.

3.2 Sea trials

3.2.1

In the course of sea trials, the casualty mentioned in [1.2.1] is to be simulated and the values of the power and speed developed in this condition are to be recorded.

Availability of the redundancies as per [1.2.4] is to be verified.

In the case of electric propulsion, when cold standby propulsion control systems are provided, it is to be checked that they are permanently installed, ready for use and easily put into operation.

Table 1 : Document to be submitted

No.	(1)	Document
1	A	Description of the independent alternative propulsion system including an analysis (2) demonstrating the availability of the operating conditions as per [1.2.2] and a description of the operations necessary to recover the propulsion and essential services
<p>(1) A : to be submitted for approval, in four copies;</p> <p>(2) This analysis may be in the form of a Failure Mode and Effect Analysis (FMEA), unless the actual arrangement of the machinery and equipment is quite simple and sufficient operating experience can be demonstrated such as to make unlikely the possibility of consequence failure in the case of a single failure. In such case the Society may consider accepting a functional description of the system in lieu of the requested analysis.</p>		

SECTION 3

DUPLICATED PROPULSION SYSTEM (AVM-DPS)

1 General

1.1 Application

1.1.1

The additional class notations **AVM-DPS** or **AVM-DPS-NS** are assigned in accordance with Pt A, Ch 1, Sec 2, [6.3.4] to self propelled ships arranged with means for duplicated propulsion system complying with the requirements of this Section.

1.1.2

This notation is granted to ships arranged with at least two propellers and the associated independent shafting, each one independently driven by separate machinery, in such a way that at least 50% of the power remains available whenever any of the propulsion machinery, the associated propeller and shafting are not available.

It is also applicable to ships arranged with at least two independent azimuth thrusters and any other equivalent arrangement.

1.1.3

When the duplicated propulsion system is designed for emergency use only (e.g. in case of loss of one of the ship's propulsion systems), the additional class notation **AVM-DPS** is assigned.

1.1.4

When the duplicated propulsion system is designed for use in conditions other than an emergency, additional class notation **AVM-DPS-NS** is assigned.

1.2 Coverage of AVM-DPS and AVM-DPS-NS notations

1.2.1 Single failure concept

The following single failures are to be considered: single failures of non-static components of the propulsion and steering systems and consequence failures, i.e. any failure of any component directly caused by a single failure of another component.

The loss of one compartment due to fire or flooding is not to be considered as a single failure. Accordingly, duplicated apparatus, such as for instance main propulsion machinery, electric power generators, different sections of the main switchboard, duplicated steering gears, etc. may be installed in the same compartment.

1.2.2 Targets

The following operating conditions are to be achieved by ships having a duplicated propulsion system, in the case of a single failure, as specified in [1.2.1]:

- At least 50% of the power still available (in the case of ships with two propellers, this condition may be

achieved either considering one propeller running at full power, with the other propeller idle, or with the two propellers running at 50% of the respective power, depending on the type of failure considered)

- Full load speed not less than 7 knots (lower speeds may be considered acceptable when the ship is provided with azimuth thrusters or similar propulsion thrusters)
- Range of 1000 nautical miles or range corresponding to 1/2 of the range achievable with the full supply of fuel, whichever is the less
- Duplicated steering rudder and steering gear, or equivalent arrangement to ensure full steering capability in case of a single failure of one rudder or steering gear
- Availability of safety systems (including fire fighting systems, bilge system, navigating lights, communication apparatus, life-saving appliances)
- Habitability conditions (including minimum lighting, ventilation, galleys, refrigerated stores, drinking water or evaporator services)
- Preservation of the cargo.

1.2.3 Services not required to be available

The following services need not to be supplied during the operation of one (or more) of the propulsion systems, when any of the propulsion system is not available e.g. due to a single failure (as defined in [1.2.1]) of any component of the propulsion plant:

- Cargo handling system
- Ballast system needed for cargo handling operation only
- Bow thrusters
- Air conditioning
- Other non essential services (for instance stabilizers, full lighting, amusement items).

1.3 Redundancy

1.3.1

When the duplicated propulsion system is designed for emergency use only (e.g. in case of single failure of any one of the non-static components of the propulsion and steering systems), for the purpose of granting the **AVM-DPS** notation the following applies:

- a) it is accepted that some of the redundancies of machinery and system normally required by the Rules may no longer be available
- b) when exemptions are foreseen by the Rules for multiple propulsion systems, they are still applicable.

1.3.2

When the duplicated propulsion system is designed for use in conditions other than an emergency, for the purpose of granting the **AVM-DPS-NS** notation the following applies:

- a) all the redundancies of machinery and system normally required by the Rules are to be kept available
- b) the exemptions mentioned in [1.3.1] b) are no longer applicable
- c) in the case of electric propulsion, cold standby propulsion control systems may be accepted in way of full redundancy provided that they are permanently installed, ready for use and easily put into operation.

1.4 Documentation to be submitted

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

2 Special arrangements

2.1 Systems for cooling, lubrication, fuel supply and starting

2.1.1 General

The systems are to be constructed such as to satisfy the conditions stipulated in [1.2.2]. In addition to what stated in the relevant parts of the Rules, the following requirements apply.

2.1.2 Pumps

For the assignment of the **AVM-DPS** notation, the systems concerned are to be provided with at least two pumps, one as a stand-by of the other. One of the two pumps may be driven by the propulsion machinery, while the other pump is to be independently driven.

For the assignment of the **AVM-DPS-NS** notation, irrespective of which of the non-static components of the propulsion and steering systems is considered not available, the systems concerned are to be provided with at least two pumps, one as a standby for the other.

2.1.3 Cooling system

In general, separate cooling systems are to be provided for each main propulsion system, unless the FMEA demonstrates that one integrated cooling system serving all propulsion systems is arranged in such a way that any single

failure of the system does not make inoperative all the propulsion systems at the same time.

In addition, the requirements under [1.3] apply depending on the notation required.

2.1.4 Lubricating oil system

Each main propulsion system is to be fitted with a separate lubrication oil systems.

In addition, the requirements under [1.3] apply depending on the notation required.

2.1.5 Fuel oil system

In general, separate fuel oil systems are to be provided for each main propulsion system, unless the FMEA demonstrates that one single fuel oil system serving all propulsion systems is arranged in such a way that any single failure of the system does not make all the propulsion systems inoperative at the same time.

In addition, the requirements under [1.3] apply depending on the notation required.

2.1.6 By-pass

Means are to be provided to by-pass and shut-off each of the components which may be subject to a single failure, described in [1.2.1], without impairing the functioning of the system itself (including machinery and equipment) or of the other systems which are to be operated in connection with navigation in emergency.

2.2 Rudders and steering gears

2.2.1

- a) A duplicated rudder and steering gear are to be arranged, unless the arrangement of the main propulsion system allows the same manoeuvrability requested by the rules in case of single failure that may prevent the use of the normal steering system, such as ships with two independent controllable pitch propellers, ships with azimuth thrusters, ships with fore and aft side thrusters.
- b) Where ships do not have traditional rudder and steering gears, being their steering capability supplied by azimuth thrusters or equivalent features, means are to be provided to allow at least the same redundancy as required in a) above.

Table 1 : Document to be submitted

Item No.	(1)	Document
1	A	Description of the duplicated propulsion system including an analysis (2) demonstrating the availability of the operating conditions as per [1.2.2] and a description of the operations necessary to recover the propulsion and essential services
<p>(1) A : to be submitted for approval, in quadruplicate;</p> <p>(2) This analysis may be in the form of a Failure Mode and Effect Analysis (FMEA). App 1 describes an acceptable procedure for carrying out the FMEA.</p>		

2.3 Electrical installations

2.3.1

Where the electrical power is supplied to the auxiliaries necessary for propulsion through a single main switchboard, the switchboard is to be arranged in at least two sections with all circuits properly distributed between the sections. In case of short circuit in one of the sections, the faulty section is to be automatically disconnected and the other section(s) is (are) to be capable of supplying the auxiliaries necessary to operate the ship under the conditions stated in [1.2.2].

2.4 Automation

2.4.1 The automation system is to be arranged in such a way as to prevent the possibility that a single failure of the control system may lead to the loss of more than one propulsion system.

3 Tests on board

3.1 Running tests

3.1.1 The duplicated propulsion system is to be subjected to the running tests required by the Rules for similar systems.

3.2 Sea trials

3.2.1

In the course of sea trials the single failures mentioned in [1.2.1] are to be simulated and the values of the power and speed developed in this condition are to be recorded.

Availability of the redundancies as per [1.3] is to be verified.

In the case of electric propulsion, when cold standby propulsion control systems are provided, it is to be checked that they are permanently installed, ready for use and easily put into operation.

SECTION 4

INDEPENDENT PROPULSION SYSTEM (AVM-IPS)

1 General

1.1 Application

1.1.1 The additional class notation **AVM-IPS** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.3.5] to self propelled ships arranged with means for independent propulsion systems complying with the requirements of this Section.

1.1.2

This notation is granted, provided that :

- a) The ship is arranged with at least two propellers and the associated independent shafting, each one independently driven by separate machinery, in such a way that at least 50% of the power remains available whenever any of the propulsion machinery and the associated propeller and shafting are out of service.

It is also applicable to ships arranged with at least two independent azimuth thrusters and any other equivalent arrangement.

- b) The propulsive installations are arranged in different compartments, in such a way that at least 50% of the power installed on board is still available whenever propulsion and auxiliary machinery arranged in any one compartment is not operating.

1.2 Coverage of AVM-IPS notation

1.2.1 Casualty

The loss (due to fire or flooding) of one compartment where propulsion, its auxiliary machinery, steering systems and the main source of electrical power are located, is to be considered. However, the collision in way of a bulkhead, and the consequent loss of two adjacent compartments due to flooding is not to be considered as a single failure for the purpose of this additional class notation.

1.2.2 Targets

The following operating conditions are to be achieved by ships having an independent propulsion system, in the case of a casualty, as specified in [1.2.1]:

- At least 50% of the power still available (in the case of ships with two propellers, this condition may be achieved either considering one propeller running at full power, with the other propeller idle, or with the two propellers running at 50% of the respective power, depending on the type of failure considered)
- Full load speed not less than 7 knots (lower speeds may be considered acceptable when the ship is provided with azimuth thrusters or similar propulsion thrusters)

- Range of 1000 nautical miles or range corresponding to 1/2 of the range achievable with the full supply of fuel, whichever is the less
- Duplicated steering rudder and steering gear, or equivalent arrangement to ensure steering capability in case of a major failure of the rudder or steering gear
- Availability of safety systems, including fire fighting systems, bilge system, navigating lights, communication apparatus, life-saving appliances
- Habitability conditions, including minimum lighting, ventilation, galleys, refrigerated stores, drinking water or evaporator services
- Preservation of the cargo.

1.2.3 Services not required to be available

The following services need not to be supplied after casualty, during the emergency operation of one (or more) of the propulsion systems, when one of the propulsion systems is not available due to the casualty described in [1.2.1]:

- Cargo handling system
- Ballast system needed for cargo handling operation only
- Bow thrusters
- Air conditioning
- Other non essential services (for instance stabilizers, full lighting, amusement items).

1.2.4 Redundancy

In the case any of the independent propulsion system is used under an emergency due to the loss of one compartment, it is accepted that some of the redundancies required normally by the rules may not be anymore available.

However, in the case of unavailability of one of the propulsion systems due to a single failure (excluding the loss of one compartment), all the redundancies of machinery and systems normally required by the Rules are to be kept available.

In the case of electric propulsion, cold standby propulsion control systems may be accepted in way of full redundancy provided that they are permanently installed, ready for use and easily put into operation.

1.3 Documentation to be submitted

- 1.3.1** The documents listed in Tab 1 are to be submitted.

2 Special arrangements

2.1 Systems for cooling, lubrication, fuel supply and starting

2.1.1 General

The propulsion systems, the propulsion auxiliaries and the main source of electrical power are to be designed and constructed such as to satisfy the conditions stipulated in [1.2.2]. In addition to what is stated in the relevant parts of the Rules and in [1.2.4], the following requirements apply.

2.1.2 Pumps

The systems concerned are to be provided with at least two pumps, one as a stand-by for the other, suitably located so that in case of loss of one compartment at least one is still available. One of the two pumps may be driven by the propulsion machinery, while the other pump is to be independently driven.

2.1.3 Cooling system

In general, separate cooling systems are to be provided for each main propulsion system, unless the FMEA demonstrates that one single cooling system, serving all propulsion systems is arranged and located in such a way that any single failure of the system, including loss of one compartment, does not make inoperative all the propulsion systems at the same time.

2.1.4 Lubricating oil system

Each main propulsion system is to be fitted with a separate lubrication oil system.

2.1.5 Fuel oil system

In general, separate fuel oil systems are to be provided for each main propulsion system, unless the FMEA demonstrates that one single fuel oil system serving all propulsion systems is arranged and located in such a way that any single failure of the system, including loss of one compartment, does not make inoperative all the propulsion systems inoperative at the same time.

2.1.6 By-pass

Means are to be provided to by-pass and shut-off each of the components which may be subject to a single failure, or malfunction due to the casualty as described in [1.2.1], without impairing the functioning of the system itself (including machinery and equipment) or of the other systems which are to be operated in connection with navigation in emergency.

2.1.7 Piping segregation

Piping systems common to the independent propulsion systems or piping systems serving one propulsion systems and passing through the spaces where another independent propulsion system is arranged are to be ducted in watertight trunks having a fire retardant resistance at least equivalent to A60 Standard and located outside B/5. The trunks are to be accessible for inspection and maintenance.

2.2 Rudders and steering gears

2.2.1

- a) A duplicated rudder and steering gear are to be arranged in separate compartments, unless the arrangement of the main propulsion system allows the same manoeuvrability requested by the Rules in case of single failure that may prevent the use of the normal steering system, such as ships with two independent controllable pitch propellers, ships with azimuth thrusters, ships with fore and aft side thrusters.
- b) Where ships do not have traditional rudder and steering gear, their steering capability being supplied by azimuth thrusters or equivalent features, means are to be provided to allow at least the same redundancy as required in a) above.

2.3 Electrical installations

2.3.1

The electrical generators are to be arranged in such a way that in case of loss of one compartment, enough power still remains available to operate the ship under the conditions stated in [1.2.1] without any stand-by generating set. In general this requirement is to be achieved arranging two main switchboards and the electric generators in two separate compartments.

2.3.2

Electrical cables and other electric apparatus serving a machinery space and passing through the spaces where other independent propulsion systems are arranged are to be ducted in trunks having a fire- retardant resistance at least equivalent to A60 Standard and located outside B/5. The trunks are to be accessible for inspection and maintenance.

The use of fire- resisting cables as an alternative to the trunks having a fire-retardant resistance at least equivalent to A60 standard will be considered on a case-by-case basis.

2.4 Automation

2.4.1

The automation system is to be arranged in such a way as to prevent the possibility that a single failure of the control system may lead to the loss of more than one propulsion system.

In the case of electric propulsion, cold standby propulsion control systems may be accepted in way of full redundancy provided that they are permanently installed, ready for use and easily put into operation.

3 Tests on board

3.1 Running tests

3.1.1 The independent propulsion system is to be subjected to the running tests required by the Rules for similar systems.

3.2 Sea trials

3.2.1

In the course of sea trials the casualty mentioned in [1.2.1] is to be simulated and the values of the power and speed developed in this condition are to be recorded.

Availability of the redundancies as per [1.2.4] is to be verified.

In the case of electric propulsion, when cold standby propulsion control systems are provided, it is to be checked that they are permanently installed, ready for use and easily put into operation.

Table 1 : Document to be submitted

Item No.	(1)	Document
1	A	Description of the independent propulsion system including an analysis (2) demonstrating the availability of the operating conditions as per [1.2.2] and a description of the operations necessary to recover the propulsion and essential services
<p>(1) A : to be submitted for approval, in four copies.</p> <p>(2) This analysis may be in the form of a Failure Mode and Effect Analysis (FMEA). App 1 describes an acceptable procedure for carrying out the FMEA.</p>		

APPENDIX 1

PROCEDURES FOR FAILURE MODE AND EFFECT ANALYSIS

1 General

1.1 Introduction

1.1.1 FMEA requirement

As specified in Sec 1, Sec 2, Sec 3 and Sec 4 in order to grant the **AVM** notations, an FMEA is to be carried out, with the exception indicated in Note (2) of Sec 1, Tab 1 to ascertain that in case of single failure to the propulsion, steering and power generating system, the ship is still capable to achieve the performances indicated in the applicable Sections as a condition for granting the notation.

1.1.2 Scope of the Appendix

This Appendix describes a failure mode and effects analysis (FMEA) and gives guidance as to how it may be applied by:

- a) explaining basic principles
- b) providing the procedural steps necessary to perform an analysis
- c) identifying appropriate terms, assumptions, measures and failure modes, and
- d) providing examples of the necessary worksheets.

1.1.3 Definition of FMEA

A practical, realistic and documented assessment of the failure characteristics of the ship and its component systems should be undertaken with the aim of defining and studying the important failure conditions that may exist.

1.1.4 FMEA principles

The FMEA is based on a single failure concept under which each considered system at various levels of a system's functional hierarchy is assumed to fail by one probable cause at a time. The effects of the postulated failure are analysed and classified according to their severity. Such effects may include secondary failures (or multiple failures) at other level(s). Any failure mode which may cause a catastrophic effect should be guarded against by system or equipment redundancy unless the probability of such failure is extremely improbable. For failure modes causing hazardous effects corrective measures may be accepted in lieu. A test programme should be drawn up to confirm the conclusions of FMEA.

1.1.5 Alternatives

While FMEA is suggested as one of the most flexible analysis techniques, it is accepted that there are other methods which may be used and which in certain circumstances may offer an equally comprehensive insight into particular failure characteristics.

1.2 Objectives

1.2.1 Primary objective

The primary objective of FMEA is to provide a comprehensive, systematic and documented investigation which establishes the important failure conditions of the ship propulsion, steering and power generation systems, as well as any other system requested by the Owner, and assesses their significance with regard to the safety of the ship and its occupants.

1.2.2 Aim of the analysis

The main aims of undertaking the analysis are to:

- a) provide ship and system designers with data to audit their proposed designs
- b) provide the Owner with the results of a study into ship's selected systems failure characteristics so as to assist in an assessment of the arrangements and measures to be taken to limit the damages consequent of the failure within acceptable limits
- c) provide the Master and crew of the ship with data to generate comprehensive training, operational and maintenance programmes and documentation.

1.3 Sister ships

1.3.1 For ships of the same design and having the same equipment, one FMEA on any one of such ships may be sufficient, but each of the other ships are to be subject to the same FMEA conclusion trials.

1.4 FMEA basics

1.4.1 Before proceeding with a detailed FMEA into the effects of the failure of the system elements on the system functional output it is necessary to perform a functional failure analysis of the considered systems. In this way only systems which fail the functional failure analysis need to be investigated by a more detailed FMEA.

1.4.2 Operational modes

When conducting a system FMEA the following typical operational modes within the normal design environmental conditions of the ships are to be considered:

- a) normal seagoing conditions at full speed
- b) maximum permitted operating speed in congested waters
- c) manoeuvring alongside
- d) seagoing conditions in emergency, as defined in Sec 1, Sec 2, Sec 3 and Sec 4.

1.4.3 Functional interdependence

This functional interdependence of these systems is also to be described in either block diagrams or fault tree diagrams or in a narrative format to enable the failure effects to be understood. As far as applicable, each of the systems to be analysed is assumed to fail in the following failure modes:

- a) complete loss of function
- b) rapid change to maximum or minimum output
- c) uncontrolled or varying output
- d) premature operation
- e) failure to operate at a prescribed time
- f) failure to cease operation at a prescribed time.

Depending on the system under consideration other failure modes may have to be taken into account.

1.4.4 Systems which can fail without catastrophic effects

If a system can fail without any hazardous or catastrophic effect, there is no need to conduct a detailed FMEA into the system architecture. For systems whose individual failure can cause hazardous or catastrophic effects and where a redundant system is not provided, a detailed FMEA as described in the following paragraphs should be followed.

Results of the system functional failure analysis should be documented and confirmed by a practical test programme drawn up from the analysis.

1.4.5 Redundant systems

Where a system, the failure of which may cause a hazardous or catastrophic effect, is provided with a redundant system, a detailed FMEA may not be required provided that:

- a) the redundant system can be put into operation or can take over the failed system within the time-limit dictated by the most onerous operational mode without hazarding the ship
- b) the redundant system is completely independent of the system and does not share any common system element the failure of which would cause failure of both the system and the redundant system. Common system element may be acceptable if the probability of failure complies with [4].
- c) the redundant system may share the same power source as the system. In such case an alternative power source should be readily available with regard to the requirement of a) above.

The probability and effects of operator error to bring in the redundant system are also to be considered.

1.5 FMEA analysis

1.5.1 The systems to be subject to a more detailed FMEA investigation at this stage are to include all those that have failed the system FMEA and may include those that have a very important influence on the safety of the ship and its occupants and which require an investigation at a deeper level than that undertaken in the system functional failure analysis. These systems are often those which have been

specifically designed or adapted for the ship, such as the craft's electrical and hydraulic systems.

2 FMEA performance

2.1 Procedures

2.1.1 The following steps are necessary to perform an FMEA:

- a) to define the system to be analysed
- b) to illustrate the interrelationships of functional elements of the system, by means of block diagrams
- c) to identify all potential failure modes and their causes
- d) to evaluate the effects on the system of each failure mode
- e) to identify failure detection methods
- f) to identify corrective measures for failure modes
- g) to assess the probability of failures causing hazardous or catastrophic effects, where applicable
- h) to document the analysis
- i) to develop a test programme
- j) to prepare FMEA report.

2.2 System definition

2.2.1 The first step in an FMEA study is a detailed study of the system to be analysed, through the use of drawings and equipment manuals. A narrative description of the system and its functional requirements is to be drawn up including the following information:

- a) general description of system operation and structure
- b) functional relationship among the system elements
- c) acceptable functional performance limits of the system and its constituent elements in each of the typical operational modes
- d) system constraints.

2.3 Development of system block diagram

2.3.1 Block diagram

The next step is to develop block diagram(s) showing the functional flow sequence of the system, both for technical understanding of the functions and operation of the system, and for the subsequent analysis. As a minimum the block diagram is to contain:

- a) breakdown of the system into major sub-systems or equipment
- b) all appropriate labelled inputs and outputs and identification numbers by which each sub-system is consistently referenced
- c) all redundancies, alternative signal paths and other engineering features which provide "fail-safe" measures.

2.3.2 Block diagrams and operational modes

It may be necessary to have a different set of block diagrams prepared for each different operational modes.

2.4 Identification of failure modes, causes and effects

2.4.1 Failure mode

Failure mode is the manner by which a failure is observed. It generally describes the way the failure occurs and its impact on the equipment or system. As an example, a list of failure modes is given in Tab 1. The failure modes listed in Tab 1 can describe the failure of any system element in sufficiently specific terms. When used in conjunction with performance specifications governing the inputs and outputs on the system block diagram, all potential failure modes can be thus identified and described. Thus, for example, a power supply may have a failure mode described as "loss of output" (29), and a failure cause "open (electrical)" (31).

Table 1 : Example of failure mode list

1	Structural failure (rupture)
2	Physical binding or jamming
3	Vibration
4	Fails to remain in position
5	Fails to open
6	Fails to close
7	Fails open
8	Fails closed
9	Internal leakage
10	External leakage
11	Fails out of tolerance (high)
12	Fails out of tolerance (low)
13	Inadvertent operation
14	Intermittent operation
15	Erratic operation
16	Erroneous indication
17	Restricted flow
18	False actuation
19	Fails to stop
20	Fails to start
21	Fails to switch
22	Premature operation
23	Delayed operation
24	Erroneous input (increased)
25	Erroneous input (decreased)
26	Erroneous output (increased)
27	Erroneous output (decrease)
28	Loss of input
29	Loss of output
30	Shorted (electrical)
31	Open (electrical)
32	Leakage (electrical)
33	Other unique failure conditions as applicable to the system characteristics, requirements and operational constraints

2.4.2 System failure

A failure mode in a system element could also be the failure cause of a system failure. For example, the hydraulic line of a steering gear system might have a failure mode of "external leakage" (10). This failure mode of the hydraulic line could become a failure cause of the steering gear system's failure mode "loss of output" (29).

2.4.3 Top-down approach

Each system should be considered in a top-down approach, starting from the system's functional output, and failure is to be assumed by one possible cause at a time. Since a failure mode may have more than one cause, all potential independent causes for each failure mode are to be identified.

2.4.4 Delay effect when operating back-up systems

If major systems can fail without any adverse effect there is no need to consider them further unless the failure can go undetected by an operator. To decide that there is no adverse effect does not mean just the identification of system redundancy. The redundancy is to be shown to be immediately effective or brought on line with negligible time lag. In addition, if the sequence is: "failure - alarm - operator action - start of back up- back up in service", the effects of delay should be considered.

2.5 Failure effects

2.5.1 Concept

The consequence of a failure mode on the operation, function, or status of an equipment or a system is called a "failure effect". Failure effects on a specific sub-system or equipment under consideration are called "local failure effects". The evaluation of local failure effects will help to determine the effectiveness of any redundant equipment or corrective action at that system level. In certain instances, there may not be a local effect beyond the failure mode itself.

2.5.2 End effect

The impact of an equipment or sub-system failure on the system output (system function) is called an "end effect". End effects should be evaluated and their severity classified in accordance with the following categories:

- a) catastrophic
- b) hazardous
- c) major
- d) minor.

The definition of these four categories of failure effects is in [4].

2.5.3 Catastrophic and hazardous effects

If the end effect of a failure is classified as hazardous or catastrophic, back-up equipment is usually required to prevent or minimize such effect. For hazardous failure effects corrective operational procedures may be generally accepted.

2.6 Failure detection

2.6.1 Detectable failures

The FMEA study in general only analyses failure effects based on a single failure in the system and therefore a failure detection means, such as visual or audible warning devices, automatic sensing devices, sensing instrumentation or other unique indications, is to be identified.

2.6.2 Non detectable failures

Where the system element failure is non-detectable (i.e. a hidden fault or any failure which does not give any visual or audible indication to the operator) and the system can continue with its specific operation, the analysis is to be extended to determine the effects of a second failure, which in combination with the first undetectable failure may result in a more severe failure effect e.g. hazardous or catastrophic effect.

2.7 Corrective measures

2.7.1 Back-up equipment response

The response of any back-up equipment, or any corrective action initiated at a given system level to prevent or reduce the effect of the failure mode of system element or equipment, is also to be identified and evaluated.

2.7.2 Corrective design provisions

Provisions which are features of the design at any system level to nullify the effects of a malfunction or failure, such as controlling or deactivating system elements to halt generation or propagation of failure effects, activating back-up or standby items or systems, are to be described. Corrective design provisions include:

- a) redundancies that allow continued and safe operation
- b) safety devices, monitoring or alarm provisions, which permit restricted operation or limit damage
- c) alternative modes of operation.

2.7.3 Manual corrective actions

Provisions which require operator action to circumvent or mitigate the effects of the postulated failure are to be described. The possibility and effect of operator error is to be considered, if the corrective action or the initiation of the redundancy requires operator input, when evaluating the means to eliminate the local failure effects.

2.7.4 Acceptability of corrective action

It is to be noted that corrective responses acceptable in one operational mode may not be acceptable at another, e.g. a redundant system element with considerable time lag to be brought into line, while meeting the operational mode "normal seagoing conditions at full speed" may result in a catastrophic effect in another operational mode, e.g. "maximum permitted operating speed in congested water".

2.8 Use of probability concept

2.8.1 Acceptance criteria

If corrective measures or redundancy as described in preceding paragraphs are not provided for any failure, as an alternative the probability of occurrence of such failure is to meet the following criteria of acceptance:

- a) a failure mode which results in a catastrophic effect is to be assessed to be extremely improbable
- b) a failure mode assessed as extremely remote is to not result in worse than hazardous effects
- c) a failure mode assessed as either frequent or reasonably probable is not to result in worse than minor effects.

2.8.2 Data

Numerical values for various levels of probabilities are laid down in [4]. In areas where there is no data from ships to determine the level of probabilities of failure other sources can be used such as:

- a) workshop test
- b) history of reliability used in other areas under similar operating conditions
- c) mathematical model if applicable.

2.9 Documentation

2.9.1 Worksheet

It is helpful to perform FMEA on worksheets. Tab 2 shows an example of worksheet.

2.9.2 Worksheet organization

The worksheets are to be organized to first display the highest system level and then proceed down through decreasing system levels.

Table 2 : FMEA worksheet

Name of system : Mode of operation : Sheet No : Date : Name of analyst :					References: System block diagram: Drawings:						
Equipment name or number	Function	Ident. No.	Failure mode	Failure cause	Failure effect		Failure detection	Corrective action	Severity of failure effect	Probability of failure (if applicable)	Remarks
					Local effect	End effect					

3 Tests and reporting

3.1 Test program

3.1.1 FMEA validation test

An FMEA test programme is to be drawn up to prove the conclusions of FMEA. It is recommended that the test programme is to include all systems or system elements whose failure would lead to:

- a) major or more severe effects
- b) restricted operations
- c) any other corrective action.

For equipment where failure cannot be easily simulated on the ship, the results of other tests can be used to determine the effects and influences on the systems and ship

3.1.2 Further investigations

The trials are also to include investigations into:

- a) the layout of control stations with particular regard to the relative positioning of switches and other control devices to ensure a low potential for inadvertent and incorrect crew action, particularly during emergencies and the provision of interlocks to prevent inadvertent operation for important system operation
- b) the existence and quality of the craft’s operational documentation with particular regard to the pre-voyage checklists. It is essential that these checks account for any unrevealed failure modes identified in the failure analysis
- c) the effects of the main failure modes as prescribed in the theoretical analysis.

3.2 Reporting

3.2.1 The FMEA report is to be a self-contained document with a full description of the craft, its systems and their functions and the proposed operation and environmental conditions for the failure modes, causes and effects to be understood without any need to refer to other plans and documents not in the report. The analysis assumptions and system block diagrams are to be included, where appropriate.

The report is to contain a summary of conclusions and recommendations for each of the systems analysed in the system failure analysis and the equipment failure analysis. It is also to list all probable failures and their probability of failure where applicable, the corrective actions or operational restrictions for each system in each of the operational modes under analysis. The report is to contain the test programme, reference any other test reports and the FMEA trials.

4 Probabilistic concept

4.1 General

4.1.1 Different undesirable events may have different orders of acceptable probability. In connection with this, it is convenient to agree on standardized expressions to be used to convey the relatively acceptable probabilities of various occurrences, i.e. to perform a qualitative ranking process.

4.2 Occurrences

4.2.1 Occurrence

Occurrence is a condition involving a potential lowering of the level of safety.

4.2.2 Failure

Failure is an occurrence in which a part, or parts, of the ship fail. A failure includes:

- a) a single failure
- b) independent failures in combinations within a system, and
- c) independent failures in combinations involving more than one system, taking into account:
 - 1) any undetected failure that is already present
 - 2) such further failures as would be reasonably expected to follow the failure under consideration, and
- d) common cause failure (failure of more than one component or system due to the same cause).

Note 1: In assessing the further failures which follow, account should be taken of any resulting more severe operating conditions for items that have not up to that time failed.

4.2.3 Event

Event is an occurrence which has its origin outside the craft (e.g., waves).

4.2.4 Error

Error is an occurrence arising as a result of incorrect action by the operating crew or maintenance personnel.

4.3 Probability of occurrences

4.3.1 Frequent

Frequent is one which is likely to occur often during the operational life of a particular ship.

4.3.2 Reasonably probable

Reasonably probable is one which is unlikely to occur often but which may occur several times during the total operational life of a particular ship.

4.3.3 Recurrent

Recurrent is a term embracing the total range of frequent and reasonably probable.

4.3.4 Remote

Remote is one which is unlikely to occur to every ship but may occur to a few ships of a type over the total operational life of a number of ship of the same type.

4.3.5 Extremely remote

Extremely remote is one which is unlikely to occur when considering the total operational life of a number of ships of the type, but nevertheless should be considered as being possible.

4.3.6 Extremely improbable

Extremely improbable is one which is so extremely remote that it should not be considered as possible to occur.

4.4 Effects

4.4.1 Effect

Effect is a situation arising as a result of an occurrence.

4.4.2 Minor effect

Minor effect is an effect which may arise from a failure, an event, or an error which can be readily compensated for by the operating crew; it may involve:

- a) a small increase in the operational duties of the crew or in their difficulty in performing their duties, or
- b) a moderate degradation in handling characteristics, or
- c) slight modification of the permissible operating conditions.

4.4.3 Major effect

Major effect is an effect which produces:

- a) a significant increase in the operational duties of the crew or in their difficulty in performing their duties which by itself should not be outside the capability of a competent crew provided that another major effect does not occur at the same time, or
- b) significant degradation in handling characteristics, or
- c) significant modification of the permissible operating conditions, but will not remove the capability to complete a safe journey without demanding more than normal skill on the part of the operating crew.

4.4.4 Hazardous effect

Hazardous effect is an effect which produces:

- a) a dangerous increase in the operational duties of the crew or in their difficulty in performing their duties of such magnitude that they cannot reasonably be expected to cope with them and will probably require outside assistance, or
- b) dangerous degradation of handling characteristics, or
- c) dangerous degradation of the strength of the ship, or
- d) marginal conditions for, or injury to, occupants, or
- e) an essential need for outside rescue operations.

4.4.5 Catastrophic effect

Catastrophic effect is an effect which results in the loss of the craft and/or in fatalities.

4.5 Safety level

4.5.1 Safety level is a numerical value characterizing the relationship between ship performance represented as horizontal single amplitude acceleration (g) and rate of acceleration (g/s) and the severity of acceleration-load effects on standing and sitting humans. The safety levels and the corresponding severity of effects on passengers and safety criteria for ship performance are defined in Tab 3.

Table 3

Effect	Criteria not to be exceeded	Value (2)	Comment
	Type of load		
LEVEL 1 MINOR EFFECT Moderate degradation of safety	Maximum acceleration measured horizontally (1)	0,20 g	0,08 g and 0,20 g/s (3) Elderly person will keep balance when holding 0,15 g and 0, 20 g/s Mean person will keep balance when holding 0,15 g and 0,80 g/s Sitting person will start holding
LEVEL 2 MAJOR EFFECT Significant degradation of safety	Maximum acceleration measured horizontally (1)	0,35 g	0,25 g and 2 g/s Maximum load for mean person keeping balance when holding 0,45 g and 10 g/s Mean person falls out of seat when not wearing seat belts
LEVEL 3 HAZARDOUS EFFECT Major degradation of safety	Collision design condition calculated Maximum structural design load, based on vertical acceleration at centre of gravity	1 g	Risk of injury to persons, safe emergency operation after collision 1 g Degradation of person safety
LEVEL 4 CATASTROPHIC EFFECT		1 g	Loss of ship and/or fatalities
<p>(1) The recording instruments used are to be such that the acceleration accuracy is better than 5% of the real value and frequency response is to be minimum 20 Hz. Antialiasing filters with maximum passband attenuation 100 + 5% are to be used</p> <p>(2) g = gravity acceleration (9,81 m/s²)</p> <p>(3) g-rate of jerk may be evaluated from acceleration/time curves</p>			

4.6 Numerical values

4.6.1 Where numerical probabilities are used in assessing compliance with requirements using the terms similar to those given above, the approximate values given in Tab 4 may be used as guidelines to assist in providing a common point of reference. The probabilities quoted should be on an hourly or per journey basis, depending on which is more appropriate to the assessment in question.

Note 1: Different occurrences may have different acceptable probabilities, according to the severity of their consequences (see Tab 5).

Table 4

Frequent	More than 10 ⁻³
Reasonably probable	10 ⁻³ to 10 ⁻⁵
Remote	10 ⁻⁵ to 10 ⁻⁷
Extremely remote	10 ⁻⁷ to 10 ⁻⁹
Extremely improbable	Whilst no approximate numerical probability is given for this, the figures used should be substantially less than 10 ⁻⁹

Table 5

SAFETY LEVEL	1	1	1	2	3	4
EFFECT ON SHIP AND OCCUPANTS	Normal	Nuisance	Operating limitations	Emergency procedures; significant reduction in safety margins; difficult for crew to cope with adverse conditions; person injuries	Large reduction in safety margin; crew over-burden because of work-load or environmental conditions; serious injuries to small number of persons	Casualties and deaths, usually with loss of ship
F.A.R. PROBABILITY (1)	Probable			Improbable		Extremely improbable
JAR-25 PROBABILITY (2)	Probable			Improbable		Extremely improbable
	Frequent		Reasonably probable	Remote	Extremely remote	
	10 ⁻⁰	10 ⁻²	10 ⁻³	10 ⁻⁵	10 ⁻⁷	10 ⁻⁹
CATEGORY OF EFFECT	Minor			Major	Hazardous	Catastrophic
<p>(1) The United States Federal Aviation Regulation</p> <p>(2) European Joint Airworthiness Regulations</p>						

Part F
Additional Class Notations

Chapter 3

AUTOMATION SYSTEMS (AUT)

SECTION 1 UNATTENDED MACHINERY SPACES (AUT-UMS)

SECTION 2 CENTRALISED CONTROL STATION (AUT-CCS)

SECTION 3 AUTOMATED OPERATION IN PORT (AUT-PORT)

SECTION 1

UNATTENDED MACHINERY SPACES (AUT-UMS)

1 General

1.1 Application

1.1.1 The additional class notation **AUT-UMS** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.4.2] to ships fitted with automated installations enabling periodically unattended operation of machinery spaces, and complying with the requirements of this Section.

Note 1: Machinery spaces are defined in Pt C, Ch 1, Sec 1, [1.4.2].

1.1.2 *The arrangements provided shall 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 Exemptions

1.2.1 For ships whose gross tonnage is less than 500 and propulsive power less than 1 MW, the requirements laid down in [1.3] and [5.4.3] do not apply.

1.2.2 For ships whose gross tonnage is less than 500 and propulsive power less than 1 MW, the requirements laid down in [4] do not apply. An alarm signal is to be activated in the following circumstances:

- a) for diesel engine propulsion plant
 - lubricating oil system low pressure
 - cylinder coolant high temperature
 - cylinder coolant low pressure or low flow rate
 - cylinder coolant make up tank low level
 - sea water cooling low pressure or low flow rate
- b) for auxiliary internal combustion engines intended for electricity production of a power higher than 37 kW, supplying essential services:
 - cylinder coolant high temperature
 - lubricating oil system low pressure.

1.2.3 For ships whose gross tonnage is less than 500 and propulsive power less than 1 MW, automatic stop is to be provided for lubricating oil failure of engines, reduction gears, clutches and reversing gears. A possible override of this automatic stop is to be available at the control stations, and an indication is to be provided at each control station, when override is activated.

1.2.4 The requirements laid down in [3.3.1] do not apply to cargo ships of less than 1 600 tons gross tonnage, insofar as the arrangements of the machinery space access make it unnecessary.

1.2.5 Fishing vessels of less than 45m in length are exempted from the application of:

- alarm system requirements given in [5.2.3] and [5.4.2]
- fire detection system requirements given in [3.2] insofar as the location of the spaces considered allows people on board to detect fire outbreaks easily, and
- requirement [3.4.4].

1.2.6 Fishing vessels of less than 75 m in length are exempted from the application of the requirements laid down in [1.3.2], [3.1.3] and [3.3.1].

1.3 Communication system

1.3.1 *A reliable means of vocal communication shall be provided between the main machinery control room or the propulsion machinery control position as appropriate, the navigation bridge and the engineer officers' accommodation.*

This means of communication is to be foreseen in collective or individual accommodation of engineer officers.

1.3.2 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.

2 Documentation

2.1 Documents to be submitted

2.1.1 In addition to those mentioned in Pt C, Ch 3, Sec 1, Tab 1, the documents in Tab 1 are required.

Table 1 : Documents to be submitted

No.	(1)	Document
1	A	Means of communication diagram
2	A	Technical description of automatic engineer's alarm and connection of alarms to accommodation and bridge, when applicable
3	A	System of protection against flooding
4	A	Fire detection system: diagram, location and cabling
(1) A : to be submitted for approval		

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 Fuel oil and lubricating oil purifiers and the auxiliary equipment and its fittings containing hot fuel oil are to be grouped in a special room or in locations ventilated by extraction; nevertheless, transfer pumps may be located outside this room.

3.1.3 Where heating is necessary, it is to be arranged with automatic control. A high temperature alarm is to be fitted and the possibility of adjusting its threshold according to the fuel quality is to be provided. Such alarm may be omitted if it is demonstrated that the temperature in the tank cannot exceed the flashpoint under the following conditions: volume of liquid corresponding to the low level alarm and maximum continuous heating power during 24 hours.

3.2 Fire detection

3.2.1 For fire detection, the requirements given in Part C, Chapter 4 are applicable.

3.2.2 *Means are to be provided to detect and give alarms at an early stage in case of fires:*

- *in boiler air supply casing and exhausts (uptakes); and*
- *in scavenging air belts of propulsion machinery*

unless the Society considers this to be unnecessary in a particular case.

3.2.3 An automatic fire detection system is to be fitted in machinery spaces of Category A as defined in Pt C, Ch 1, Sec 1, [1.4.1] intended to be unattended.

3.2.4 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.

3.2.5 The fire detection indicating panel is to be located on the navigating bridge, fire control station, or other accessible place where a fire in the machinery space will not render it inoperative.

3.2.6 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 throughout the navigating bridge and the accommodation area of the personnel responsible for the operation of the machinery space.

3.2.7 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.

3.2.8 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.

3.2.9 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.

3.2.10 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.

3.2.11 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.

3.2.12 The fire detection indicating panel is to be provided with facilities for functional testing.

3.2.13 The fire detecting system is to be fed automatically from the emergency source of power by a separate feeder if the main source of power fails.

3.2.14 Facilities are to be provided in the fire detecting system to manually release the fire alarm from the following places:

- passageways having entrances to engine and boiler rooms
- the navigating bridge
- the control station in the engine room.

3.3 Fire fighting

3.3.1 Unless otherwise stated, pressurisation of the fire main at a suitable pressure by starting a main fire pump and carrying out the other necessary operations is to be possible from the navigation bridge. Alternatively, the fire main system may be permanently under pressure.

3.3.2 The arrangements for the ready availability of water supply are to be:

- in passenger ships of 1 000 gross tonnage and upwards, such that at least one effective jet of water is immediately available from any hydrant in an interior location and so as to allow the continuation of the output of water by the automatic starting of a required fire pump
- in passenger ships of less than 1 000 gross tonnage and in cargo ships, to the satisfaction of the Society.

3.3.3 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.

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 1, Sec 10.

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 at the main control station, the engineers' accommodation area and the navigating bridge.

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 shall 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 shall 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 shall 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 shall 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.

4.2 Diesel propulsion plants

4.2.1

When a diesel engine is used for the propulsion plant, monitoring and control of equipment is to be performed respectively 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, control and monitoring functions of steam turbines are required according to Tab 4.

4.3.2 Turbine spinning is to take place automatically at regular intervals when the shaft line is stopped during manoeuvring.

4.3.3 Spinning is not allowed until the equipment is in a safe position.

4.3.4 Lubrication of gear and turbines is to be automatically ensured until the plant is stopped (driven oil pump or gravity tank).

4.3.5 If a special crash astern sequence is provided, it is to be carried out through a separate device or by placing the control gear in a special position; precautions are to be taken to avoid its unintended use.

According to the type of plant, this control may be achieved by:

- cancelling the low vacuum shutdown device
- shutting off the steam to the ahead turbine
- opening the turbine cylinder drain valves, the astern stop valve and the astern manoeuvring valve.

Table 2 : Monitored parameters for main propulsion crosshead diesel engine (1/1/2020)

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote					
Identification of system parameter	Alarm activation	Remote indication	Slow-down with alarm	Shut-down with alarm	Automatic start of stand by pump with alarm
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				
• 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	X	X
• Lubricating oil to crosshead bearing pressure when separate	L	R	X	X	X
• Lubricating oil to camshaft pressure when separate	L			X	X
	LL			X	X
• Lubricating oil to camshaft temperature when separate	H				
• Lubricating oil inlet temperature	H				
• Thrust bearing pads or bearing outlet temperature	H		X	X	
	HH			X	
• Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: - the engine main, crank and crosshead bearing oil outlet; or - the engine main, crank and crosshead bearing) (5)	X		X		
• Flow rate cylinder lubricator (each apparatus)	L		X		
<p>(1) Not required, if the coolant is oil taken from the main cooling system of the engine.</p> <p>(2) Where outlet flow cannot be monitored due to engine design, alternative arrangement may be accepted.</p> <p>(3) Where one common cooling space without individual stop valves is employed for all cylinder jackets.</p> <p>(4) Where separate lubricating oil systems are installed (e.g. camshaft, rocker arms, etc.), individual level alarms are required for the tanks.</p> <p>(5) When required by Pt C, Ch 1, Sec 2, [4.3.5] or by SOLAS Reg.II-1/47.2.</p> <p>(6) Unless provided with a self-contained lubricating oil system integrated with the turbocharger.</p> <p>(7) Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangements may be accepted. Continuous monitoring of inlet temperature in combination with specific intervals for bearing inspection in accordance with the turbocharger manufacturer's instructions may be accepted as an alternative.</p> <p>(8) Only required for turbochargers of Categories B and C. (see Pt C, Ch 1, Sec 14)</p>					

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote					
Identification of system parameter	Alarm activation	Remote indication	Slow-down with alarm	Shut-down with alarm	Automatic start of stand by pump with alarm
• Level in lubricating oil tanks or oil sump, as appropriate (4)	L				
• Common rail servo oil pressure	L				
Turbocharger system					
• Lubricating oil to turbocharger inlet pressure (6)	L				
• Turbocharger lubricating oil outlet temperature on each bearing (7)	H				
• Speed of turbocharger (8)	H	R			
Piston cooling system					
• Piston coolant inlet pressure	L		X (1)		
					X
• Piston coolant outlet temperature on each cylinder	H		X		
• Piston coolant outlet flow on each cylinder (2)	L		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		X		
					X
• Cylinder fresh cooling water outlet temperature (from each cylinder) or cylinder water outlet temperature (general) (3)	H		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				
<p>(1) Not required, if the coolant is oil taken from the main cooling system of the engine.</p> <p>(2) Where outlet flow cannot be monitored due to engine design, alternative arrangement may be accepted.</p> <p>(3) Where one common cooling space without individual stop valves is employed for all cylinder jackets.</p> <p>(4) Where separate lubricating oil systems are installed (e.g. camshaft, rocker arms, etc.), individual level alarms are required for the tanks.</p> <p>(5) When required by Pt C, Ch 1, Sec 2, [4.3.5] or by SOLAS Reg.II-1/47.2.</p> <p>(6) Unless provided with a self-contained lubricating oil system integrated with the turbocharger.</p> <p>(7) Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangements may be accepted. Continuous monitoring of inlet temperature in combination with specific intervals for bearing inspection in accordance with the turbocharger manufacturer's instructions may be accepted as an alternative.</p> <p>(8) Only required for turbochargers of Categories B and C. (see Pt C, Ch 1, Sec 14)</p>					

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote					
Identification of system parameter	Alarm activation	Remote indication	Slow-down with alarm	Shut-down with alarm	Automatic start of stand by pump with alarm
Starting and control air system					
• Starting air pressure before main shut off valve	L	R			
• Control air pressure	L				
• Safety air pressure	L				
Scavenge air system					
• Scavenging air receiver pressure		R			
• Scavenging air box temperature (detection of fire in receiver, see [3.2.2])	H		X		
• Scavenging air receiver water level	H				
Exhaust gas system					
• Exhaust gas temperature after each cylinder	H	R	X		
• Exhaust gas temperature after each cylinder, deviation from average	H				
• Exhaust gas temperature before each turbocharger	H	R			
• Exhaust gas temperature after each turbocharger	H	R			
Miscellaneous					
• Engine speed (and direction of speed when reversible)		R			
• Engine overspeed	H			X	
• Wrong way	X				
• Control, safety, alarm system power supply failure	X				
<p>(1) Not required, if the coolant is oil taken from the main cooling system of the engine.</p> <p>(2) Where outlet flow cannot be monitored due to engine design, alternative arrangement may be accepted.</p> <p>(3) Where one common cooling space without individual stop valves is employed for all cylinder jackets.</p> <p>(4) Where separate lubricating oil systems are installed (e.g. camshaft, rocker arms, etc.), individual level alarms are required for the tanks.</p> <p>(5) When required by Pt C, Ch 1, Sec 2, [4.3.5] or by SOLAS Reg.II-1/47.2.</p> <p>(6) Unless provided with a self-contained lubricating oil system integrated with the turbocharger.</p> <p>(7) Where outlet temperature from each bearing cannot be monitored due to the engine/turbocharger design alternative arrangements may be accepted. Continuous monitoring of inlet temperature in combination with specific intervals for bearing inspection in accordance with the turbocharger manufacturer's instructions may be accepted as an alternative.</p> <p>(8) Only required for turbochargers of Categories B and C. (see Pt C, Ch 1, Sec 14)</p>					

Table 3 : Monitored parameter for main propulsion trunk piston diesel engine (1/1/2020)

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote					
Identification of system parameter	Alarm activation	Remote indication	Slow-down with alarm	Shut-down with alarm	Automatic start of stand by pump with alarm
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				
• 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	X
• Lubricating oil filter differential pressure	H	R			
• Lubricating oil inlet temperature	H	R			
• Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: - the engine main and crank bearing oil outlet; or - the engine main and crank bearing) (1)	X			X	
• Flow rate cylinder lubricator (each apparatus)	L		X		
• Common rail servo oil pressure	L				
Turbocharger system					
• Lubricating oil to turbocharger inlet pressure (2)	L	R			
• Turbocharger lub oil temp. each bearing (4)	H	R			
• Speed of turbocharger (5)					
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
<p>(1) When required by Pt C, Ch 1, Sec 2, [4.3.5] or by SOLAS Reg.II-1/47.2. For each engine one oil mist detector (or engine bearing temperature monitoring system or equivalent device) having two independent outputs for initiating the alarm and shut-down would satisfy the requirement for independence between alarm and shut-down system.</p> <p>(2) Unless provided with a self-contained lubricating oil system integrated with the turbocharger.</p> <p>(3) For engine power > 500 kW/cyl.</p> <p>(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.</p> <p>(5) Only required for turbochargers of Categories B and C (see Pt C, Ch 1, Sec 14).</p>					

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote					
Identification of system parameter	Alarm activation	Remote indication	Slow-down with alarm	Shut-down with alarm	Automatic start of stand by pump with alarm
• Cylinder water outlet temperature (general)	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			
• Engine overspeed	H			X	
• Control, safety, alarm system power supply failure	X				
<p>(1) When required by Pt C, Ch 1, Sec 2, [4.3.5] or by SOLAS Reg.II-1/47.2. For each engine one oil mist detector (or engine bearing temperature monitoring system or equivalent device) having two independent outputs for initiating the alarm and shut-down would satisfy the requirement for independence between alarm and shut-down system.</p> <p>(2) Unless provided with a self-contained lubricating oil system integrated with the turbocharger.</p> <p>(3) For engine power > 500 kW/cyl.</p> <p>(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.</p> <p>(5) Only required for turbochargers of Categories B and C (see Pt C, Ch 1, Sec 14).</p>					

Table 4 : Steam turbines used for main propulsion

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	Stand by Start	Stop
Lubricating oil system							
• Supply pressure						X	
	L						
	LL			X			
• Cooler inlet temperature	H						
• Temperature of reduction gear bearings	H (1)						
• Temperature of turbine bearings and thrust bearings	H (1)						
<p>(1) Alternatively: group alarm associated with means to find out the fault.</p> <p>(2) Sensor to be located near the normal level.</p>							

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	Stand by Start	Stop
• Level of return tank	L (2)						
• Level of gravity tank	L (2)						
Miscellaneous							
• Main turbine speed		R			X		
	H			X			
• Main turbine vibration	H						
	HH			X			
• Main turbine axial displacement	H						
	HH			X			
• Automatic spinning fault	X						
• Gland seals fault at exhaust fans	X						
• Gland seals pressure of steam supply	L + H						
(1) Alternatively: group alarm associated with means to find out the fault.							
(2) Sensor to be located near the normal level.							

4.3.6 For steam propulsion plants, control and monitoring functions of main boilers are required according to Tab 5.

4.3.7 Additional arrangements may be required according to the type of boilers considered, in particular in the case of forced circulation boilers, concerning unexpected circulation shutdown.

Reheat cycle type boilers are also to be subjected to a special examination.

4.3.8 Where the propulsive plant includes several main boilers, automatic shutdown of one is to involve automatic slowdown of the turbines with a view to saving the maximum available steam for electricity production.

4.3.9 Unless special arrangements are provided, fire in boiler air ducts is to be detected.

4.4 Gas turbine propulsion plants

4.4.1 For gas turbines, monitoring and control elements are required according to Tab 6.

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 trip-

ping 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 5 : Main boilers

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Main boiler			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Fuel oil system							
• Fuel oil delivery pressure or flow	L						
• Fuel oil temperature after heater or viscosity fault	L + H						
					X		
Combustion							
• Flame failure of each burner	X						
• Failure of atomising fluid	X						
• Boiler casing and economiser outlet smoke temperature (in order to detect possible fire outbreak)	H						
	HH			X			
• Burning air flow or equivalent	L						
General steam system							
• Superheated steam pressure	L + H	R					
					X		
• Superheated steam temperature	H						
	L			X			
• Desuperheated steam pressure (except if pressure is that of superheated steam)	L						
• Desuperheated steam temperature	H						
• Lifting of safety valve (or equivalent: for instance high pressure alarm)	X						
• Water level inside the drum of each boiler					X		
	L	R					
	H						X (1)
	HH			X			
	LL			X			
(1) Stop of the feed water pump							

Table 6 : 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 7 are to be controlled or monitored.

4.5.5 Converters

For converters, parameters according to Tab 8, Tab 9 and Tab 10 are to be monitored or controlled.

4.5.6 Smoothing coil

For the converter reactor, parameters according to Tab 11 are to be monitored or controlled.

4.5.7 Propulsion electric motor

For propulsion electric motors, parameters according to Tab 12 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 and clutches, parameters according to Tab 13 are to be monitored or controlled.

4.6.2 For controllable pitch propellers, parameters according to Tab 14 are to be monitored or controlled.

4.6.3 For reduction gears and reversing gears, parameters according to Tab 15 are to be monitored or controlled.

Table 7 : 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 8 : 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 9 : 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			
Overspeed	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 10 : 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 11 : 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						
Cooling air 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 12 : 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			

Table 13 : Shafting and clutches of propulsion machinery

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Main Engine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Temperature of each shaft thrust bearing (not applicable for ball or roller bearings)	H		X				
Stern tube bush oil gravity tank level	L						
Clutch lubricating oil temperature	H						
Clutch oil tank level	L						
Clutch control oil pressure	L						
	LL					X	

Table 14 : 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						
Oil tank level	L						
Control oil pressure	L						
	LL					X	

Table 15 : Reduction gears/reversing gears of propulsion machinery

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Main Engine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Lubricating oil temperature	H (1)	R (1)					
Lubricating oil pressure	L (1)	R				X	
	LL			X			
Oil tank level	L (1)						
Plain bearing temperature	H						
	HH						
(1) May be omitted in the case of restricted navigation notation.							

4.7 Auxiliary systems

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
- sea water to main condenser (main turbines)
- hydraulic control of clutch, CPP or main thrust unit
- thermal fluid systems (thermal fluid heaters).

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.

Some of the propulsive plants may be partially used for reasons of economy (use of one shaft line or one propulsion engine for instance). If so, automatic change-over, necessary for this exploitation mode, is to be provided.

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

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 if the flashpoint of the fuel oil can be exceeded.

4.7.8 For auxiliary systems, the following parameters, according to Tab 16 to Tab 26 are to be monitored or controlled.

Table 16 : 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 17 : 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	Standby 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 18 : Auxiliary boilers

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Boiler			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Water level	L + H			X	X		
Fuel oil temperature	L + H			X	X		
Flame failure	X			X			
Combustion air supply fan low pressure				X			
Temperature in boiler casing (fire)	H						
Steam pressure	H (1)			X	X		
Steam temperature				X (2)			

(1) When the automatic control does not cover the entire load range from zero load.
 (2) For superheated steam over 330°C.

Table 19 : 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)						
<p>(1) Or sight-glasses on the overflow pipe. (2) Or alternative arrangement as per Pt C, Ch 1, Sec 10, [9.1.7]. (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.</p>							

Table 20 : 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, [9.1.7]	H						
Sludge tank level	H						
Lubricating oil centrifugal purifier overflow (stop of oil supply)	H						X

Table 21 : Thermal oil system

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			System			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Forced draft fan stopped				X			
Thermal fluid temperature	H						
				X			
Thermal fluid pressure							X
Flow through each element	L			X			
Heavy fuel oil temperature or viscosity	H + L				X		
Burner flame failure	X			X			
Flue gas temperature (when exhaust gas heater)	H			X			
Expansion tank level	L						X (1)
(1) Stop of burner and fluid flow.							

Table 22 : Hydraulic oil system

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			System			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Pump pressure	L + H						
Service tank level	L (1)						
(1) The low level alarm is to be activated before the quantity of lost oil reaches 100 litres or 50% of the circuit volume, whichever is the lesser.							

Table 23 : Boiler feed and condensate system

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			System			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Sea water flow or equivalent	L					X	
Vacuum	L						
	LL			X			
Water level in main condenser (unless justified)	H + L						
					X		
	HH			X			
Salinity of condensate	H						
Feed water pump delivery pressure	L					X	
Feed water tank level	L						
Deaerator inside temperature or pressure	L + H (1)						
Water level in deaerator	L + H						
Extraction pump pressure	L						
Drain tank level	L + H						
(1) In the case of forced circulation boiler.							

Table 24 : 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			

Table 25 : 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 26 : 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 (1/1/2017)

Monitored parameters for which alarms are required to identify machinery faults and associated safeguards are listed in Tab 27 and Tab 28. These alarms are to be indicated at all the control locations for the individual machinery at least as common alarms; in at least one of the control position and preferably at the centralized control position, if any, all alarms are to be individually indicated. For communication of alarms from the machinery space to the bridge area and accommodation for engineering personnel, 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 may be arranged at a main control station or, alternatively, at subsidiary control stations. 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 Unless otherwise justified, 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 prevent the alarm system from operating. Common sensors for alarms and automatic slowdown functions are acceptable as specified in each specific table.

Table 27 : Auxiliary trunk piston reciprocating I.C. engines driving generators (1/1/2020)

Identification of system parameter	Alarm	Remote indication	Slow-down with alarm	Shut-down with alarm	Automatic start of stand-by pump with alarm
Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote					
Fuel oil viscosity or temperature before injection pumps	L + H				
Fuel oil leakage from high pressure pipes	H				
Lubricating oil temperature	H				
Lubricating oil pressure	L			X (1)	
Activation of oil mist detection arrangements (or activation of the temperature monitoring systems or equivalent devices of: - the engine main and crank bearing oil outlet; or - the engine main and crank bearing) (3)	X			X	
Pressure or flow of cooling water	L				
Temperature of cooling water or cooling air	H				
Level in cooling water expansion tank, if not connected to main system	L				
Overspeed activated				X	
Level in fuel oil daily service tank	L				
Starting air pressure	L				
Exhaust gas temperature after each cylinder (2)	H				
Common rail fuel oil pressure	L				
Common rail servo oil pressure	L				
Speed of turbocharger (4)	H				
<p>(1) Not applicable to emergency generator set. (2) For engine power above 500 kW/cyl. (3) When required by Pt C, Ch 1, Sec 2, [4.3.5] or by SOLAS Reg.II-1/47.2. For each engine one oil mist detector (or engine bearing temperature monitoring system or equivalent device) having two independent outputs for initiating the alarm and shut-down would satisfy the requirement for independence between alarm and shut-down system. (4) Only required for turbochargers of Categories B and C (see Pt C, Ch 1, Sec 14).</p>					

Table 28 : Auxiliary steam turbines

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote	Monitoring		Automatic control				
			Turbine			Auxiliary	
Identification of system parameter	Alarm	Indic	Slow-down	Shut-down	Control	Standby Start	Stop
Turbine speed		local					
					X		
	HH			X			
Lubricating oil supply pressure	L					X	
	LL			X			

5.1.4 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.

5.1.5 (1/1/2017)

Where remote indications (R) are mentioned in the tables of this Section, they are required only for ships having the class notation **AUT-CCS** (Sec 2) i.e. which are operated with the machinery space unattended but under continuous supervision from a position where control and monitoring devices are centralized, without the traditional watch service being provided by personnel in the machinery space.

5.2 Alarm system design

5.2.1 The alarm system and associated sensors are to be capable of being tested during normal machinery operation.

5.2.2 Insulation faults on any circuit of the alarm system are to generate an alarm, when an insulated earth distribution system is used.

5.2.3 An engineers' alarm is to be activated when the machinery alarm has not been accepted in the machinery spaces or control room within 2 minutes.

5.2.4 The alarm system is to have a connection to the engineers' public rooms and to each of the engineers' cabins through a selector switch, to ensure connection to at least one of those cabins.

5.3 Machinery alarm system

5.3.1 The local silencing of the alarms on the bridge or in accommodation spaces is not to stop the audible machinery space alarm.

5.3.2 (1/1/2017)

Unless required otherwise in the specific paragraphs, machinery faults are to be indicated at all the control locations for machinery at least as common alarms; in at least one of the control position and preferably at the centralized control position, if any, all alarms are to be individually indicated.

5.4 Alarm system on navigating bridge

5.4.1 Alarms associated with faults requiring speed reduction or automatic shut-down are to be separately identified on the bridge.

5.4.2 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.

5.4.3 Individual alarms are to be provided at the navigation bridge indicating any power supply failures of the remote control of propulsion machinery.

6 Safety systems

6.1 General

6.1.1 Safety systems of different units of the machinery plant are to be independent. Failure in the safety system of one part of the plant is not to interfere with the operation of the safety system in another part of the plant.

6.1.2

In order to avoid undesirable interruption in the operation of machinery, the system is to intervene sequentially after the operation of the alarm system by:

- starting of standby units
- load reduction or shutdown, such that the least drastic action is taken first.

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

6.1.3

If overriding devices of the required automatic reduction of power (slowdown) are provided, they are to be so arranged as to preclude their inadvertent operation, and a suitable alarm is to be activated by their operation.

6.1.4

If overriding devices of the required automatic stops (shut-down) are provided, they are to be so arranged as to preclude their inadvertent operation, and a suitable alarm is to be operated by their activation. When the engine is stopped automatically, restarting after restoration of normal operat-

ing conditions is to be possible only after manual reset, e.g. bypassing the control lever through the 'stop' position.

Automatic restarting is not permissible.

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 to the Society and may be as follows.

7.1.2 The tests of equipment carried out alongside the quay 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 2 minutes in each one: astern slow, astern half, astern full, full ahead, half ahead, stop, full astern, stop, ahead dead slow, half ahead, then increasing the power until «underway» position for the remaining time.
- 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

CENTRALISED CONTROL STATION (AUT-CCS)

1 General

1.1 Application

1.1.1 The additional class notation **AUT-CCS** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.4.3] to ships fitted with a machinery installation operated and monitored from a centralised control station, and complying with the requirements of this Section.

It applies to ships which are intended to be operated with machinery spaces unattended, but with continuous supervision from a position where control and monitoring devices of machinery are centralised.

Note 1: Machinery spaces are defined in Pt C, Ch 1, Sec 1, [1.4.2].

1.1.2 Remote indications for continuous supervision of the machinery are to be located in a centralised control position, to allow a watch service of the machinery space.

1.2 Exemptions

1.2.1 Exemptions mentioned in Sec 1, [1.2] may also be considered for the notation **AUT-CCS**.

1.3 Communication system

1.3.1 A means of communication is to be provided between the centralised control station, the navigation bridge, the engineers's accommodation and, where necessary, the machinery spaces.

1.3.2 Means of communication are to be operable even in the case of failure of the main source of electrical power supply.

1.3.3 The requirements mentioned in Sec 1, [1.3] are applicable.

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, documents according to Tab 1 are required.

3 Fire and flooding precautions

3.1 General

3.1.1 The requirements mentioned in Sec 1, [3] are applicable, except for Sec 1, [3.4.5].

3.1.2 The flooding alarms are to be transmitted to the centralised control position.

Table 1 : Documentation to be submitted

No.	I/A (1)	Document
1	A	Means of communication diagram
2	A	Central control position layout and location
3	A	System of protection against flooding
(1) A: to be submitted for approval I: to be submitted for information.		

4 Control of machinery

4.1 Propulsion plant operation

4.1.1 The centralised control position is to be designed, equipped and installed so that the machinery operation is as safe and effective as if it were under direct supervision.

4.1.2 Monitoring and control of main systems are to be designed according to the requirements mentioned in Sec 1, [4]. Additional indications in the centralised control position are required, and shown in the table with the symbol R.

4.1.3 In the centralised 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), unless an automatic restart is provided.

4.1.4 Automatic restart of essential auxiliaries for propulsion and steering may be replaced by remote control from the centralised control position.

4.1.5 The status of machinery (in operation or on standby) and all parameters crucial to the safe operation of essential machinery are to be shown at the centralised control position.

4.1.6 Under all sailing conditions including manoeuvring, the speed, direction of thrust and, if applicable, the pitch of the propeller are also to be fully controllable from the centralised control position.

4.1.7 In addition to the requirements in Sec 1, [4.1.10], the device to prevent overload, when automatic or remote controlled from the centralised control position, is to be fitted with an alarm indicating the necessity of slowing down.

4.2 Control position location

4.2.1 The centralised control position is to be located in the machinery space or adjacent to it. Other arrangements are to be submitted to the satisfaction of the Society.

4.2.2 If the centralised control position is an enclosed space located in the machinery spaces, it is to be provided with two safe fire escapes.

5 Alarm system

5.1 General

5.1.1 The alarm system is to be designed according to Sec 1, [5].

5.1.2 Every alarm is to be indicated visually and audibly at the centralised control position. If an alarm function has not received attention locally within a limited time, an alarm clearly audible in the engineers' accommodation is to be activated.

6 Safety system

6.1 General

6.1.1 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 deactivate the overspeed protection.

6.1.2 Safety systems provided with automatic operation may be replaced by remote manual operation from the centralised control position.

7 Testing

7.1 Tests after completion

7.1.1 Tests are to be carried out of all systems which are required to be in operation at the quay, such as the fuel oil purifier system, electrical power generation, auxiliary steam generator, etc.

7.2 Sea trials

7.2.1

The sea trials are to demonstrate the proper operation of automation systems. A detailed test program is to be submitted for approval. As a minimum, the following are to be tested:

- the remote control system of propulsion machinery
- electrical production and distribution
- efficiency of the fire detection and fire alarm system
- protection against flooding
- continuous operation in all sailing conditions, including manoeuvring, for 4 hours with unattended machinery spaces and at least one person in CCS.

SECTION 3 AUTOMATED OPERATION IN PORT (AUT-PORT)

1 General

1.1 Application

1.1.1 The additional class notation **AUT-PORT** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.4.4] to ships fitted with automated installations enabling the ship's operation in port or at anchor without personnel specially assigned for the watch-keeping of the machinery in service, and complying with the requirements of this Section.

1.1.2 The arrangements provided are to be such as to ensure that the safety of the ship in port is equivalent to that of a ship having the machinery spaces manned.

1.2 Exemptions

1.2.1 Exemptions mentioned in Sec 1, [1.2] may also be considered for the notation **AUT-PORT**.

1.2.2 Ships whose gross tonnage is less than 1600 and fishing vessels of less than 75 metres in length are exempted from the requirements in [3.1.2].

1.2.3 Fishing vessels of less than 45 metres in length are exempted from the requirements in [3.1.2] insofar as the location of the spaces considered allows people on board to easily detect fire outbreaks.

1.3 Communication system

1.3.1 The requirements of Sec 1, [1.3] are applicable.

2 Documentation

2.1 Documents to be submitted

2.1.1 In addition to the those mentioned in Pt C, Ch 3, Sec 1, Tab 1, Pt C, Ch 3, Sec 1, Tab 2 and Sec 1, Tab 1, documents according to Tab 1 are required.

Table 1 : Documentation to be submitted

No.	I/A (1)	Document
1	A	Means of communication diagram
2	A	Technical description of automatic engineers' alarm and connection of alarms to accommodation and bridge, when applicable
3	A	System of protection against flooding
4	I	List of machinery to be in operation in port
(1) A: to be submitted for approval I: to be submitted for information.		

3 Fire and flooding precautions

3.1 General

3.1.1 The requirements given in Sec 1, [3] are applicable unless otherwise indicated below.

3.1.2 The remote control of the main fire pump for the pressurisation of the fire main may be located at the bridge running station if the wheelhouse and officers' cabins are close together. Failing this, such remote control is to be fitted at a place close to the officers' cabins or to the engine room exit. Alternatively, the fire main may be permanently under pressure.

3.1.3 Transmission to the navigating bridge of fire alarm and flooding is not required, but these alarms are to be directed at the intervention personnel.

4 Control of machinery

4.1 Plant operation

4.1.1 The machinery and systems which are to be in operation in port are to be designed according to Sec 1, [4], unless otherwise stated.

4.1.2 The requirements regarding electrical production for propulsion Sec 1 are not applicable.

4.1.3 The operation of auxiliaries, other than those associated with propulsion, is to be designed according to Sec 1.

5 Alarm system

5.1 General

5.1.1 The alarm system is to be designed according to Sec 1, [5], unless otherwise stated in this Section.

5.1.2 The alarm system is to be designed so as to inform of any situation which requires attention of the personnel on watch.

For this purpose, an audible and visual alarm is to be activated in the centralised control station, in the engineers' public rooms and at each engineer's cabin through a selector switch. Any other arrangement is to be to the satisfaction of the Society.

6 Testing

6.1 Tests after completion

6.1.1 Tests are to be carried out of all systems which are required to be in operation in port, such as: the fuel oil purifier system, electrical power generation, auxiliary steam generator, etc.

Part F
Additional Class Notations

Chapter 4

INTEGRATED SHIP SYSTEMS

**SECTION 1 CENTRALISED NAVIGATION EQUIPMENT
(SYS-NEQ)**

SECTION 2 INTEGRATED BRIDGE SYSTEMS (SYS-IBS)

SECTION 3 COMMUNICATION SYSTEM (SYS-COM)

SECTION 1 CENTRALISED NAVIGATION EQUIPMENT (SYS-NEQ)

1 General

1.1 Application

1.1.1 The additional class notation **SYS-NEQ** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.5.2], to ships fitted with a centralised navigation control system so laid out and arranged that it enables normal navigation and manoeuvring operation of the ship by two persons in cooperation.

This notation is assigned when the requirements of Articles [1] to [5], [7] and [8] of this Section are complied with.

1.1.2 The additional class notation **SYS-NEQ-1** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.5.2], when, in addition to [1.1.1] above, the installation is so arranged that the navigation and manoeuvring of the ship can be operated under normal conditions by one person for periodical one man watches. This notation includes specific requirements for prevention of accidents caused by the operator's unfitness.

This notation is assigned when the requirements of this Section are complied with.

1.1.3 The composition and the qualification of the personnel on watch remain the responsibility of the Owner and the Administration. The authorisation to operate the ship in such condition remains the responsibility of the Administration.

1.2 Operational Assumptions

1.2.1 The requirements are framed on the following assumptions:

- Plans for emergencies are specified and the conditions under which a one man watch is permitted are clearly defined in an operations manual which is acceptable to the Administration with which the ship is registered.
- The manning of the bridge watch is in accordance with the national regulations in the country of registration and for the waters in which the ship is operating.
- The requirements of the International Convention on Standards of Training Certification and Watchkeeping for seafarers (STCW) and other applicable statutory regulations are complied with.

1.3 Regulations, guidelines, standards

1.3.1 The requirements are based on the understanding that the applicable regulations and guidelines issued by the

International Maritime Organisation are complied with, in particular:

- a) Regulation 12, Chapter V of the 1974 "International Convention for the Safety of Life at Sea" (SOLAS) and applicable amendments
- b) the international Regulations for Preventing Collisions at Sea and all other relevant Regulations relating to Radiotelegraphy, Radiotelephony and Safety of Navigation required by Chapters IV and V of SOLAS 1974, as amended
- c) the Provisional Guidelines for the Conduct of Trials in which the Officer of the Navigational Watch acts as the sole Lookout in Periods of Darkness (MSC Circular 566 of 2 July 1991)
- d) IMO Performance Standards for navigational equipment applicable to:
 - magnetic compasses (Resolution A382)
 - gyrocompasses (Resolution A424)
 - radar equipment (Resolutions A222, A278, A477)
 - ARPA (Resolution A422)
 - speed and distance measuring equipment (Resolution A478)
 - echo sounding equipment (Resolution A224)
 - radio direction finder (Resolution A223)
 - electronic navigational aids – general requirements (Resolution A574)
 - VHF Radio installation (Resolution A609)
 - automatic pilots (Resolution A342)
 - rate-of-turn indicators (Resolution A526).

1.3.2 The requirements and guidelines of the following international standards are applicable:

- ISO 8468 "Ships bridge layout and associated equipment – Requirements and guidelines"
- IEC 872: ARPA – Operational and performance requirements – Methods of testing and required test results
- IEC 936: Shipborne radar – Operational and performance requirements – Methods of testing and required test results
- IEC 1023: Marine speed and distance measuring equipment (SDME) – Operational and performance requirements – Methods of testing and required test results
- IEC Document 18 (Central Office) 534: Special features – Control and instrumentation.

1.3.3 Additional requirements may be imposed by the national authority with whom the ship is registered and/or by the Administration within whose territorial jurisdiction it is intended to operate.

1.4 Definitions

1.4.1 Terms used in the requirements are defined below:

- Acquisition: the selection of those target ships requiring a tracking procedure and the initiation of their tracking
- Alarm: a visual and audible signal indicating an abnormal situation
- ARPA: automatic radar plotting aid
- Backup navigator: any individual, generally an officer, who has been designated by the ship's Master to be on call if assistance is needed on the navigation bridge
- Bridge: that area from which the navigation and control of the ship is exercised, including the wheelhouse and bridge wings
- Bridge wings: those parts of the bridge on both sides of the ship's wheelhouse which, in general, extend to the ship side
- CPA: closest point of approach, i.e. the shortest target ship-own ship calculated distance that will occur in the case of no change in course and speed data
- Conning position: place on the bridge with a commanding view and which is used when manoeuvring and controlling a ship
- Display: means by which a device presents visual information to the navigator, including conventional instrumentation
- Ergonomics: application of the human factor in the analysis and design of equipment, work and working environment
- Field of vision: angular size of a scene that can be observed from a position on the ship's bridge
- Lookout: activity carried out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision
- Navigation: all tasks relevant for deciding, executing and maintaining course and speed in relation to waters and traffic
- Navigator: person navigating, operating bridge equipment and manoeuvring the ship
- NAVTEX: an international maritime radio telex system sponsored by IMO and IHO, which automatically receives the broadcast telex information such as navigational, meteorological warnings and search and rescue (SAR) alerts on a 24-hour watch basis
- Normal conditions: when all systems and equipment related to navigation operate within design limits, and environmental conditions such as weather and traffic do not cause excessive workload to the officer of the watch

- Officer of the watch: person responsible for safe navigating, operating of bridge equipment and manoeuvring of the ship
- Radar plotting: the whole process of target detection, tracking, calculation of parameters and display of information
- Seagoing ship: ship navigating on the high seas, i.e. areas along coasts and from coast to coast
- TCPA: time to closest point of approach
- Tracking: process of observing the sequential changes in the position of a target, to establish its motion
- Vigilance system: system provided to verify the officer of the watch's alertness
- Watch alarm: alarm that is transferred from the bridge to the Master and the backup navigator in the event of any officer of the watch deficiency (absence, lack of alertness, no response to another alarm/warning, etc.)
- Wheelhouse: enclosed area of the bridge
- Workstation: position at which one or several tasks constituting a particular activity are carried out.

2 Documentation

2.1 Documents to be submitted

2.1.1 In addition to the documents mentioned in Pt C, Ch 3, Sec 1, Tab 1, and the requirement in Pt C, Ch 3, Sec 1, [2.1.1], documents according to Tab 1 are to be submitted.

2.1.2 Additional plans and specifications are to be submitted for approval, if requested by the Society.

3 Bridge layout

3.1 General

3.1.1 The bridge configuration, the arrangement of consoles and equipment location are to enable the officer of the watch to perform navigational duties and other functions allocated to the bridge as well as maintain a proper lookout from a convenient position on the bridge, hereafter referred to as a 'workstation'.

3.1.2 A workstation for navigation and traffic surveillance/manoeuvring is to be arranged to enable efficient operation by one person under normal operating conditions. All relevant instrumentation and controls are to be easily visible, audible and accessible from the workstation.

3.1.3 The bridge layout design and workstations are to enable the ship to be navigated and manoeuvred safely by two navigators in cooperation.

Table 1 : Documentation to be submitted

No.	I/A (1)	Documentation
1	A	General arrangement of bridge and wheelhouse showing the position of the control console and panels
2	A	Plans showing the field of vision from each workstation
3	A	List and specification of navigational equipment fitted on the bridge and references (Manufacturer, type, national authority approval...)
4	A	Functional block diagram indicating the relationship between the items of navigational equipment and between them and other equipment
5	A	List of alarms and instrumentation fitted on the bridge
6	A	Diagram of electrical supply to the navigational equipment
7	A	Diagram of the system linking the bridge alarms with the other operational locations (2)
8	A	Diagram of the navigation officer's call system (2)
9	A	Diagram of the communication systems (2)
10	A	Diagram of the vigilance systems (2)
11	A	Test program including test method
12	I	List of the intended area of operation of the ship
<p>(1) A : to be submitted for approval I : to be submitted for information.</p> <p>(2) Documents to be submitted only when a SYS-NEQ-1 notation is requested.</p>		

3.1.4

The requirements and guidelines of the ISO 8468 Standard are to be regarded as a basic reference for the design of bridge layout.

The application of item 4.1.5 of the above-mentioned ISO Standard is not compulsory for the assignment of the notation **SYS-NEQ**.

4 Bridge instrumentation and controls**4.1 General**

4.1.1 The instrumentation and controls at the workstation for navigation and traffic surveillance/manoeuvring are to be arranged to enable the officer of the watch to:

- determine and plot the ship's position, course, track and speed
- analyse the traffic situation
- decide on collision avoidance manoeuvres
- alter course
- change speed
- effect internal and external communications related to navigation and manoeuvring, radio communication on the VHF
- give sound signals
- hear sound signals
- monitor course, speed, track, propeller revolutions (pitch), rudder angle and depth of water
- record navigational data (may be manually recorded from data available at the workstation).

4.1.2 Irrespective of their size, gross tonnage and date of construction, all ships assigned the additional notation **SYS-NEQ** are to be equipped with the instrumentation and controls described in [4.2] to [4.4] below.

4.2 Safety of navigation: collision-grounding

4.2.1 The ship is to be equipped with an ARPA system including or associated with a collision avoidance system, meeting the requirements of IMO Resolution A422 (XI). The ARPA function may be independent or built into the radar equipment. The system is to be based on the assumption that all floating objects may come onto a collision course with own ship if the object's course is changed up to 45° with its speed maintained. A warning is to be given to the navigator at a time which is to be adjustable in the range of 6 to 30 minutes, having regard to the time to danger (TCPA).

The whole equipment is to feature the following capability:

- true motion and relative motion modes
- daylight-visible display
- automatic acquisition and tracking of 20 radar targets
- guard zone system, featuring adjustable parameters, notably warning and alarm set for CPA and TCPA
- simulator function showing the likely effects of a course or speed change in relation to tracked targets
- incorporated self-checking properties.

4.2.2 An automatic pilot is to be provided and monitored by an off-course alarm addressed to the navigator, in case of malfunction. This alarm is to be derived from a system independent from the automatic steering system. An overriding control device is to be provided at the navigating and manoeuvring workstation.

Alternatively, track piloting equipment may be considered.

The navigator is to be given an alarm in the event of deviation from the planned route. This alarm is to be adjustable having regard to the time to danger or grounding.

Pre-warning is to be given at the approach of a way-point.

An alarm is to be initiated when the water depth beneath the ship is less than a predetermined value.

4.3 Position fixing

4.3.1 Ships are to be provided with the following position systems:

- a) position fixing systems appropriate to the intended service areas
- b) at least two independent radar, one of which is to operate within the X-band
- c) a gyrocompass system
- d) a speed log system
- e) an echo sounding system.

4.4 Controls - Communication

4.4.1 Ships are to be provided with the following control and communication:

- a) a propulsion plant remote control system, located on the bridge
- b) a whistle control device
- c) a window wipe and wash control device
- d) a main workstation console lighting control device
- e) steering pump selector/control switches
- f) an internal communication system
- g) a VHF radiotelephone installation
- h) a wheelhouse heating/cooling control device
- i) a NAVTEX automatic receiver and recorder.

Note 1: The systems or controls under a) to g) are to be fitted within the reach of the officer of the watch when seated or standing at the main navigating and manoeuvring workstation.

5 Design and reliability

5.1 General

5.1.1 Where computerised equipment is interconnected through a computer network, failure of the network is not to prevent individual equipment from performing its individual functions.

5.2 Power supply

5.2.1 Local distribution panels are to be arranged for all items of electrically operated navigational equipment. These panels are to be supplied by two exclusive circuits, one fed from the main source of electrical power and one from an emergency source of electrical power. Each item of navigational equipment is to be individually connected to its distribution panel. The power supplies to the distribution panels are to be arranged with automatic change-over facil-

ities between the two sources. Failure of the main power supply to the distribution panels is to initiate an audible and visual alarm.

5.2.2 Following a loss of power which has lasted for 30 seconds or less, all primary functions are to be readily reinstated. Following a loss of power which has lasted for more than 30 seconds, as many primary functions as practical are to be readily reinstated.

5.3 Environmental conditions

5.3.1 Shipborne navigational equipment specified in IMO Publication 978-88-04E "PERFORMANCE STANDARDS FOR NAVIGATIONAL EQUIPMENT" is to be capable of continuous operation under the conditions of various sea states, vibration, humidity, temperature and electromagnetic interference likely to be experienced in the ship in which it is installed.

5.3.2 Equipment which has been additionally specified in this notation is to comply with the environmental conditions specified in Pt C, Ch 2, Sec 2 for control and instrumentation equipment, computers and peripherals for shipboard use.

6 Prevention of accidents caused by operator's unfitness

6.1 Bridge safety system

6.1.1 A vigilance system is to be provided to indicate that an alert officer of the navigational watch is present on the bridge.

6.1.2 Any system used for verification of the officer of the navigational watch's alertness is not to cause undue interference with the performance of bridge functions.

6.1.3 The system is to be so designed and arranged that it cannot be operated in an unauthorised manner, as far as practicable.

6.1.4 Any system used for periodical verification of the officer of the navigational watch's alertness is to be adjustable up to 12 minute intervals and constructed, fitted and arranged so that only the ship's Master has access to the component for setting the appropriate intervals.

6.1.5 The system is to provide for the acknowledgement by the officer of the navigational watch at the navigating and traffic surveillance/manoeuvring workstation and other appropriate locations in the bridge from where a proper lookout may be kept.

6.1.6 Such system is to be connected to the alarm transfer system described in [6.3].

6.1.7 An alarm is to operate on the bridge in the event of a failure of the bridge safety systems.

6.1.8 The requirements of [6.1.1] to [6.1.7] do not prevent the Society from accepting any technical systems that ade-

quately verify or help maintain the alertness of the officer of the watch at intervals up to 12 minutes.

6.2 Field of vision

6.2.1 For the purpose of performing duties related to navigation, traffic surveillance and manoeuvring, the field of vision from a workstation is to be such as to enable observation of all objects which may affect the safe conning of the ship. The field of vision from a workstation is to be in accordance with the guidelines on navigation bridge visibility, as specified in IMO Resolution A708 as it applies to new ships.

For other functions, other workstations may be arranged singularly or in combination, provided the field of vision complies with the foregoing.

6.3 Alarm/warning transfer system - Communications

6.3.1 Any alarm/warning that requires bridge operator response is to be automatically transferred to the Master and, if he deems it necessary, to the selected backup navigator and to the public rooms, if not acknowledged on the bridge within 30 seconds.

Such transfer is to be carried out through the systems required by [6.3.3] and [6.3.7], where applicable.

6.3.2 Acknowledgement of alarms/warnings is only to be possible from the bridge.

6.3.3 The alarm/warning transfer is to be operated through a fixed installation.

6.3.4 Provision is to be made on the bridge for the operation of a navigation officer call-alarm to be clearly audible in the spaces of [6.3.1].

6.3.5 The alarm transfer system is to be continuously powered and have an automatic change-over to a standby power supply in the case of loss of normal power supply.

6.3.6 At all times, including during blackout, the officer of the watch is to have access to facilities enabling two-way speech communication with another qualified officer.

The bridge is to have priority over the communication system.

Note 1: The automatic telephone network is acceptable for this purpose, provided that it is automatically supplied during blackouts and that it is available in the locations specified in [6.3.1].

6.3.7 If, depending on the shipboard work organisation, the backup navigator may attend locations not connected to the fixed installation(s) described in [6.3.1], he is to be provided with a portable wireless device enabling both the alarm/warning transfer and the two-way speech communication with the officer of the watch.

6.3.8 External sound signals from ships and fog signals that are audible on open deck are also to be audible inside the wheelhouse; a transmitting device is to be provided to reproduce such signals inside the wheelhouse (recommended frequency range: 70 to 700 Hertz).

6.4 Bridge layout

6.4.1 The bridge configuration, the arrangement of consoles and equipment location are to enable the officer of the watch to maintain a proper lookout from a convenient workstation.

6.4.2 A workstation for navigation and traffic surveillance/manoeuvring is to be arranged to enable efficient operation by one person under normal operating conditions.

7 Ergonomic recommendations

7.1 Lighting

7.1.1 The lighting required on the bridge is to be designed so as not to impair the night vision of the officer on watch. Lighting used in areas and at items of equipment requiring illumination whilst the ship is navigating is to be such that night vision adaptation is not impaired, e.g. red lighting. Such lighting is to be arranged so that it cannot be mistaken for a navigation light by another ship. It is to be noted that red lighting is not to be fitted over chart tables so that possible confusion in colour discrimination is avoided.

7.2 Noise level

7.2.1 The noise level on the bridge is not to interfere with verbal communication and mask audible alarms.

7.3 Vibration level

7.3.1 The vibration level on the bridge is not to be higher than that stipulated in Pt A, Ch 3, Sec 6, [2].

7.4 Wheelhouse space heating/cooling

7.4.1 Unless otherwise justified, wheelhouse spaces are to be provided with heating and air cooling systems. System controls are to be readily available for the officer of the watch.

7.5 Navigator's safety

7.5.1 There are to be no sharp edges or protuberances on the surfaces of the instruments and equipment installed on the bridge which could cause injury to the navigator.

7.5.2 Sufficient handrails or the equivalent are to be fitted inside the wheelhouse or around instruments and equipment therein for safety in bad weather.

7.5.3 Adequate means are to be made for anti-slip of the floor, whether it is dry or wet.

7.5.4 Doors to the bridge wings are to be easy to open and close. Means are to be provided to hold the doors open at any position.

7.5.5 Where provision for seating is made in the wheelhouse, means for securing are to be provided, having regard to storm conditions.

8 Testing

8.1 Tests

8.1.1 Documentary evidence in the form of certification and/or test results is to be submitted to the satisfaction of the Society. Where acceptable evidence is not available, the requirements of Pt C, Ch 3, Sec 6 are applicable.

8.1.2 Shipboard tests and sea trials are to be carried out in accordance with the test procedures submitted for approval in advance to the Society. Tests and trials are to be performed under the supervision of the Surveyors.

8.1.3 After fitting on board, the installations are to be submitted to tests deemed necessary to demonstrate correct operation. Some tests may be carried out at quay side, while others are to be effected at sea trials.

SECTION 2

INTEGRATED BRIDGE SYSTEMS (SYS-IBS)

1 General

1.1 Application

1.1.1 The additional class notation **SYS-IBS** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.5.3], to ships fitted with an integrated bridge system which allows simplified and centralised bridge operation of the main functions of navigation, manoeuvring and communication, as well as monitoring from the bridge of other functions, as specified in [1.1.2].

This notation is assigned when the requirements of this Section are complied with.

1.1.2 The following functions are to be part of the **SYS-IBS**:

- a) passage execution:
 - situation of navigation (position of the ship, local weather indication, ship heading....)
 - navigation control and manoeuvring control (collision avoidance included)
- b) communication system:
 - external communication linked with the safety of the ship (distress equipment)
 - internal communication system
- c) monitoring of the machinery installation
- d) monitoring of specific cargo operations (loading and discharging of cargo, logging of cargo data, loading calculation)
- e) pollution monitoring
- f) monitoring of heating, ventilation and air conditioning for passenger ships.

1.1.3 This Section specifies the minimum requirements for the design, manufacture, integration and testing of integrated bridge systems (SYS-IBS). The latter are to comply with IMO Resolution MSC 64.(67) Annex 1 of the International Maritime Organisation (IMO), and other relevant IMO performance standards, in order to meet the functional requirements contained in applicable IMO instruments, not precluding multiple usage of equipment and modules or the need for duplication.

1.1.4 The notation presumes efficient ship management by suitably qualified personnel providing for, inter alia, the uninterrupted functional availability of systems and for human factors.

1.2 Reference Regulations

1.2.1 IEC 60945: 1996, Maritime navigation and radio-communication equipment and systems - General requirements - Methods of testing and required test results

IEC 61162 (all parts), Maritime navigation and radiocommunication equipment and systems - Digital interfaces

ISO 8468: 1990, Ship's bridge layout and associated equipment - requirements and guidelines

ISO 9001: 1991, Quality systems - Model for quality assurance in design, development, production, installation and servicing

ISO 9002: 1991, Quality systems - Model for quality assurance in production, installation and servicing

IMO International Convention for the Safety of Life at Sea (SOLAS): 1997, Consolidated edition

IMO SOLAS: 1997, draft revision of SOLAS V, NAV 43/J/1 - Safety of navigation

IMO A.823: 1995, Performance standards for automatic radar plotting aids (ARPAs)

IMO A.830: 1995, Code on alarms and indicators (amendments to IMO Resolution A.686: 1991)

IMO A.694: 1991, General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids

IMO MSC.64 (67): 1996, Annex 1 - Performance standards for integrated bridge systems (SYS-IBS)

IMO MSC.64 (67): 1996, Annex 4 - amendments to A.477: 1981, Performance standards for radar equipment

IMO MSC/Circular 566: 1991, Provisional guidelines on the conduct of trials in which the officer of the navigational watch acts as the sole lookout in periods of darkness

Additional IMO requirements may be applicable to SYS-IBS.

1.3 Definitions

1.3.1 Configuration of complete system: all operational functions of the SYS-IBS as installed.

1.3.2 Configuration available: operation(s) allocated to and available at each workstation.

1.3.3 Configuration in use: operation(s) and task(s) currently in use at each workstation.

1.3.4 Connectivity: a complete data link and the presence of valid data.

1.3.5 Essential functions: functions related to determination, execution and maintenance of safe course, speed and position of the ship in relation to the waters, traffic and weather conditions.

Such functions include but are not limited to:

- route planning
- navigation

- collision avoidance
- manoeuvring
- docking
- monitoring of internal safety systems
- external and internal communication related to safety in bridge operation and distress situations.

1.3.6 Essential information: that information which is necessary for the monitoring and control of essential functions.

1.3.7 Functionality: ability to perform an intended function. The performance of a function normally involves a system of displays, controls and instrumentation.

1.3.8 IMO requirements: IMO Conventions, Regulations, Resolutions, Codes, Recommendations, Guidelines, Circulars and related ISO and IEC standards.

1.3.9 Integrated bridge system (SYS-IBS): any combination of systems which are interconnected in order to allow centralised access to sensor information or command/control from workstations to perform two or more of the following operations:

- passage execution
- communications
- machinery control
- loading, discharging and cargo control, including HVAC for passenger ships.

1.3.10 Integrity: ability of a system to provide users with accurate, timely, complete and unambiguous information and warnings within a specified time when the system is not in use.

1.3.11 Latency: time interval between an event and the resulting information, including time for processing, transmission and reception.

1.3.12 Multi-function display: a single visual display unit which can present, either simultaneously or through a series of selectable pages, information from more than one operation of an SYS-IBS.

1.3.13 Novel systems or equipment: systems or equipment which embody new features not fully covered by provisions of SOLAS - Chapter V but which provide an at least equivalent standard of safety.

1.3.14 Part: individual subsystem, equipment or module.

1.3.15 Performance check: a representative selection of short qualitative tests, to confirm correct operation or essential functions of the SYS-IBS.

1.3.16 Sensor: a device which provides information to or is controlled or monitored by the SYS-IBS.

1.4 Abbreviations

1.4.1 Abbreviations used in this Section and/or in the standards and annexes:

AIS : Automatic identification system

ARPA : Automatic radar plotting aid

DSC : Digital selective calling

EGC : Enhanced group call

EPIRB : Emergency position indicating radio beacon

GMT : Greenwich Mean Time

HF : High frequency

INMARSAT: International Mobile Satellite Organisation

ISO : International Standards Organisation

ITU-R : International Telecommunication Union - radio sector

ITU-T : International Telecommunication Union - telecommunication sector

MARPOL: IMO Convention for the prevention of pollution by ships

MEPC : IMO Marine Environmental Protection Committee

MF : Medium Frequency

MSC : IMO Maritime Safety Committee

NAV : IMO Subcommittee on Safety of Navigation

NAVTEX: System for broadcast and reception of maritime safety information

OOW : Officer of the watch

r.p.m. : Revolutions per minute

UTC : Universal coordinated time

VDU : Visual display unit

VHF : Very high frequency.

2 Documentation

2.1 Documents to be submitted

2.1.1 In addition to the documents mentioned in Pt C, Ch 3, Sec 1, Tab 1 and the requirement in Pt C, Ch 3, Sec 1, [2.1.1], documents according to Tab 1 are to be submitted.

3 General requirements

3.1 General

3.1.1 The SYS-IBS is to comply with all applicable IMO requirements as contained in the reference regulations [2.1] or other relevant IEC Standards. Parts executing multiple operations are to meet the requirements specified for each individual function they can control, monitor or perform. By complying with these requirements, all essential functions remain available in the event of a single failure. Therefore, means for operation independent of the SYS-IBS are not required.

3.1.2 Each part of an SYS-IBS are to meet the relevant requirements of IMO Resolution A.694(17) as detailed in IEC 60495. As a consequence, the SYS-IBS is in compliance with these requirements without further environmental testing to IEC 60945.

3.1.3 Where implemented, passage execution is not to be interfered with by other operations.

3.1.4 A failure of one part is not to affect the functionality of other parts except for those functions directly dependent upon the information from the defective part.

3.2 Integration

3.2.1 The functionality of the SYS-IBS is to ensure that operations are at least as effective as with stand-alone equipment.

3.2.2 Continuously displayed information is to be reduced to the minimum necessary for safe operation of the ship. Supplementary information is to be readily accessible.

3.2.3 Integrated display and control functions are to adopt a consistent man-machine interface philosophy and implementation. Particular consideration is to be given to:

- symbols
- colours
- controls
- information priorities
- layout.

3.2.4 Where multi-function displays and controls are used to perform functions necessary for safe operation of the ship, they are to be duplicated and interchangeable.

3.2.5 It is to be possible to display the complete system configuration, the available configuration and the configuration in use.

3.2.6 Any unintentional change of a configuration is to be brought to the immediate attention of the user. An unintentional change of the configuration in use is, in addition, to activate an audible and visual alarm.

3.2.7 Each part to be integrated is to provide details of its operational status and the latency and validity of essential information. Means is to be provided within the SYS-IBS to make use of this information.

3.2.8 An alternative means of operation is to be provided for essential functions.

3.2.9 For integrated machinery control, it is to be possible for all machinery essential for the safe operation of the ship to be controlled from a local position.

3.2.10 An alternative source of essential information is to be provided. The SYS-IBS is to identify loss of either source.

3.2.11 The source of information (sensor, result of calculation or manual input) is to be displayed continuously or on request.

3.3 Data exchange

3.3.1 Interfacing within the SYS-IBS and to an SYS-IBS is to comply with IEC 61162, as applicable.

3.3.2 Data exchange is to be consistent with safe operation of the ship. The Manufacturer is to specify in the system specification document (SSD) the maximum permissible latency for each function considering the use of fast control loop, normal control loop, essential information and other information.

3.3.3 Corrupted data are not to be accepted by the SYS-IBS. Corrupted or missing data are not affect functions which are not dependent on this data.

Table 1 : Documentation to be submitted

No.	I/A (1)	Documentation
1	A	General arrangement of the bridge showing the position of the control console and panels
2	A	Plans showing the field of vision from each workstation
3	A	List and specification of navigational equipment fitted on the bridge and references (Manufacturer, type...)
4	A	List of alarms and instrumentation fitted on the bridge
5	I	List and specification of automation equipment fitted on the bridge and references (Manufacturer, type...)
6	A	Functional block diagram indicating the relationship between the items of navigational equipment and between them and other equipment
7	A	Functional block diagram of automation equipment remote controlled from the bridge
8	A	Diagram of electrical supply to the navigational and automation equipment fitted on the bridge
9	A	Diagram of the system linking the bridge alarms with the other operational locations
10	A	Diagram of the navigation officer's call system
11	A	Diagram of the communication systems
12	A	Diagram of the vigilance systems
13	A	Test program including test method
(1) A: to be submitted for approval I: to be submitted for information.		

3.3.4 The integrity of data flowing on the network is to be ensured.

3.3.5 The network is to be such that in the event of a single fault between nodes there is an indication, the sensors and displays on the network continue to operate and data transmission between them is maintained.

3.3.6 A failure in the connectivity is not to affect independent functionality.

3.4 Failure analysis

3.4.1 A failure analysis is to be performed and documented.

3.4.2 Parts, functions and connectivity are to be identified.

3.4.3 Possible failures of parts and connectivity associated with essential functions and information are to be identified.

3.4.4 Consequences of failures with respect to operation, function or status of the SYS-IBS are to be identified.

3.4.5 Each failure is to be classified with respect to its impact on the SYS-IBS taking into account relevant characteristics, such as detectability, diagnosability, testability, replaceability and compensating and operating provisions.

3.4.6 The results of the failure analysis are to confirm the possibility of continued safe operation of the ship.

3.5 Quality assurance

3.5.1 The SYS-IBS is to be designed, developed, produced, installed, and serviced by companies certified to ISO 9001 or ISO 9002, as applicable.

4 Operational requirements

4.1 Human factors

4.1.1 The SYS-IBS is to be capable of being operated by personnel holding appropriate certificates.

4.1.2 The man-machine interface (MMI) is to be designed to be easily understood and in a consistent style for all integrated functions.

4.1.3 Operational information is to be presented in a readily understandable format without the need to transpose, compute or translate.

4.1.4 Indications, which may be accompanied by a short low intensity acoustic signal, are to occur when:

- an attempt is made to execute an invalid function
- an attempt is made to use invalid information.

4.1.5 If an input error is detected by the system it is to require the operator to correct the error immediately. Messages actuated by an input error are to guide the correct responses, e.g.: not simply "Invalid entry", but "Invalid entry, re-enter set point between 0 and 10".

4.1.6 Layered menus are to be presented in a way which minimises the added workload to find and return from the desired functions.

4.1.7 An overview is to be easily available to assist the operator in the use of a multiple page system. Each page is to have a unique identifier.

4.1.8 Where multi-function displays are used, they are to be in colour. Continuously displayed information and functional areas, e.g. menus, are to be presented in a consistent manner.

4.1.9 For actions which may cause unintended results, the SYS-IBS is to request confirmation from the operator.

Note 1: Examples of such actions are:

- attempting to change position of next waypoint while in track mode steering
- attempting to switch on bow thruster when insufficient electrical power is available.

4.1.10 Functions requested by the operator are to be acknowledged or clearly indicated by the SYS-IBS on completion.

4.1.11 Default values, where applicable, are to be indicated by the SYS-IBS when requesting operator input.

4.1.12 For bridge operation by one person, special consideration is to be given to the technical requirements in [1].

4.2 Functionality

4.2.1 It is always to be clear from where essential functions may be performed.

4.2.2 The system management is to ensure that one user only has the control of an input or function at the same time; all other users are to be informed of this by the SYS-IBS.

4.3 Training

4.3.1 Manufacturers of integrated bridge systems are to provide training possibilities for the ship's crew. This training may take place ashore or on board and is to be carried out using suitable material and methods to cover the following topics:

a) General understanding and operation of the system:

- knowledge and understanding of the system's configuration and application
- reading and understanding of the operating manual
- usage and understanding of brief description and instructions provided on the bridge
- usage and understanding of electronic "HELP"-functions, if provided in the system
- familiarisation with the system using safe trial modes

b) Mastering of uncommon conditions in the system:

- detecting and locating of failures
- resetting the system to safe default values and modes
- operating safely without certain sensor data or parts
- possibilities for repair on board

- identifying the potential for unintended results
- c) Methods and support for providing the above-mentioned training may be, for example:
- printed material
 - training courses
 - video films
 - computer based learning programmes
 - simulation of different situations or data
 - recorded speech.

5 Technical requirements

5.1 Sensors

5.1.1 In order to ensure an adequate system functionality, the sensors employed are to be able to comply with the following, as applicable:

- a) ensure communication compatibility in accordance with the relevant international marine interface Standard IEC 1162; and provide information about their operational status and about the latency and validity of essential information
- b) respond to a command with minimal latency and indicate receipt of invalid commands, when remote control is employed
- c) have the capability to silence and re-establish the audible portion of the local alarm
- d) have information documented about deterministic and stochastic errors and how they are handled, insofar as signals are pre-processed locally, e.g. plausibility check.

5.2 Alarm management

5.2.1 The SYS-IBS alarm management as a minimum is to comply with the requirements of the Code on Alarms and Indicators, 1995 (IMO Resolution A.830(19)) (see also IMO A.686: 1991).

5.2.2 Appropriate alarm management on priority levels (see [5.2.5]) and grouping of alarms based on operations and tasks is to be provided within the SYS-IBS.

Note 1: The purpose of grouping of alarms is to achieve the following:

- to reduce the variety in type and number of audible and visual alarms and indicators so as to provide quick and unambiguous information to the personnel responsible for the safe operation of the ship
- to readily identify any abnormal situation requiring action to maintain the safe operation of the ship
- to avoid distraction by alarms which require attention but do not require immediate action to restore or maintain the safe operation of the ship.

5.2.3 The number of alarms is to be kept as low as possible by providing indications for information of lesser importance.

5.2.4 Alarms are to be displayed so that the reason for the alarm and the resulting functional restrictions can be easily understood. Indications are to be self-explanatory.

5.2.5 Alarms are to be prioritised as follows:

- a) emergency alarms: alarms which indicate that immediate danger to human life or to the ship and its machinery exists and that immediate action is to be taken
- b) distress, urgency and safety alarms: alarms which indicate that a mobile unit or a person is in distress, or the calling station has a very urgent message concerning the safety of a mobile unit or a person, or has an important warning to transmit
- c) primary alarms: alarms which indicate a condition that requires prompt attention to prevent an emergency condition as specified in statutory and classification rules and regulations
- d) secondary alarms: alarms which are not included above.

5.3 Human factors

5.3.1 A multi-function display, if used, is to be a colour display.

5.3.2 The size, colour and density of text and graphic information presented on a display are to be such that it may be easily read from the normal operator position under all operational lighting conditions.

Note 1: See ISO 8468 - 6.2.3.

5.3.3 Symbols used in mimic diagrams are to be standardised throughout the system's displays.

5.3.4 All information is to be presented on a background providing high contrast and emitting as little light as possible at night.

5.4 Power interruptions and shutdown

5.4.1 If subjected to an orderly shutdown, the SYS-IBS is, upon turn-on, to come to an initial default state.

5.4.2 After a power interruption full functionality of the SYS-IBS is to be available following recovery of all subsystems. The SYS-IBS is not to increase the recovery time of individual subsystem functions after power restoration.

5.4.3 If subjected to a power interruption, upon restoration of power the SYS-IBS is to maintain the configuration in use and continue automated operation as far as practicable. Safety related automatic functions, e.g. automated steering control, are only to be restored upon confirmation by the operator.

5.5 Power supply

5.5.1 General power supply requirements are summarised in Tab 2.

5.5.2 Power supply requirements applying to parts of the SYS-IBS as a result of other IMO requirements remain applicable.

5.5.3 The SYS-IBS is to be supplied:

- from the main and emergency sources of power with automated change-over through a local distribution board with provision to preclude inadvertent shutdown,
- from a transitional source of power for a duration of not less than 1 min, and
- where required in Tab 2, parts of the SYS-IBS are also to be supplied from a reserve source of power.

6 Testing

6.1 Introduction

6.1.1 The testing proposed is intended to supplement and not replace testing of parts that is required to meet the relevant IMO performance standards. It is intended to ensure that when parts are integrated there is no degradation of their individual functionality and the overall system meets the requirements contained in Sec 1, [4] and Sec 1, [5].

6.1.2 In all instances the performance standards for parts will form the minimum test requirement for an integrated system. Parts previously type approved will not require re-testing. Bridge-mounted parts for which no IMO performance standard exists are to be tested to the requirements of IEC 60945. Integration aspects of the SYS-IBS are to require testing to ensure compliance with requirements contained in Sec 1, [4] and Sec 1, [5].

6.1.3 The test strategy is to demonstrate that when operated by suitably trained personnel, the SYS-IBS increases the safety and efficiency of the management of the ship.

6.2 General requirements

6.2.1 The Manufacturer is to state the operations intended to be performed by the SYS-IBS.

6.2.2 Since each SYS-IBS may integrate an individual set of operations and parts, it is not possible to define in advance which IMO requirements apply. Therefore, the following steps are to be taken with each individual SYS-IBS considered:

- a) Produce a matrix of the applicable IMO requirements:
 - collect IMO requirements referring generally to SYS-IBS (e.g. SOLAS Chapter V and Code on Alarms and Indicators (A.686 and A.830))
 - collect IMO requirements applicable to the operations stated in [6.2.1] (e.g. if a radar/ARPA is integrated, collect IMO MSC.64 (67), annex 4 and A.823)
 - identify the individual parts of the SYS-IBS and their interfaces
 - identify parts executing multiple operations
 - identify functions necessary to perform the operations stated in [6.2.1]
 - identify power supply requirements for the individual parts of the SYS-IBS from Tab 2.

- b) Verify the validity of the appropriate type approval certificates.
- c) Verify that all functions identified in a) are performed.

6.2.3 In addition, the following is to be carried out:

- a) Confirm compliance with IEC 60945 by one of the following:
 - a valid type approval certificate
 - a test certificate issued by an appropriate body
 - successful completion of appropriate tests.
- b) Confirm by examination of the (SSD)(s) that operational functions in addition to passage execution are implemented on a non-interference basis (see [3.1.3]).
- c) Independently disable each part identified in a) and determine by a test that only those functions dependent on the disabled part are affected (see [3.1.4]).
- d) Confirm by examination that only minimum information necessary for the safe operation of the ship and as applicable to the configuration in use is continuously displayed and that supplementary information is readily accessible (see [3.2.2]).
- e) Where IMO requirements governing the symbols, colours, controls, information priorities and layout of the integrated display and control functions exist, confirm compliance by examination. Where no such requirements exist, confirm by examination that the use of symbols, colours, controls, information priorities and layout is consistent (see [3.2.3]).
- f) Where used, confirm by examination that there are at least two identical and interchangeable multi-function displays and controls (see [3.2.4]).
- g) Confirm by examination that it is possible to display the configuration of the complete system, the configuration available and the configuration in use (see [3.2.5]).
- h) Disable a part of the configuration in use and confirm that an audible and visual alarm is activated (see [3.2.6]).
- i) Confirm by examination of relevant certificates and documentation that each part integrated in the SYS-IBS provides details of its operational status and latency and validity of essential information. Confirm by a performance check that changes in status of the parts and of the latency and validity of information are used by the SYS-IBS in a safe and unambiguous manner (see [3.2.7]).
- j) Confirm by examination of the SSD that there is an alternative means of performing each applicable essential function (see [3.2.8]).
- k) Confirm by examination of the SSD that for integrated machinery control, it is possible for all machinery essential for the safe operation of the ship to be controlled from a local position.
- l) Confirm by examination that there is an alternative source of essential information. Confirm by a performance check that loss of essential information is recognised by the SYS-IBS.
- m) Confirm by examination that the source of information is displayed continuously or on request (see [3.2.11]).

- n) Confirm by examination of relevant certificates and documentation that interfacing complies with IEC 1161, as applicable (see [3.3.1]).
 - o) Confirm by examination of the SSD that the stated latencies are appropriate to all intended operations. Confirm by examination of the Manufacturer's SSD that the stated latencies are achieved while the network is loaded to its maximum expected loading (see [3.3.2]).
 - p) Confirm by a performance check that corrupted data is not accepted by the SYS-IBS and that corrupted and missing data does not affect functions which are not dependent on this data.
 - q) Confirm by examination of the Manufacturer's SSD that, as a minimum, data includes a check-sum in accordance with IEC 1162-1 and that, in addition, limit checking is applied to essential data (see [3.3.4]).
 - r) Create a representative number of single faults between network nodes and confirm that there is an indication of the fault, the displays and sensors continue to operate and data transmission is maintained.
 - s) Identify the system connectivity by examination of the SSD. Independently interrupt each connection and determine by a performance check that only those functions dependent on the connection are affected and that all essential functions can still be performed (see [3.3.6]).
 - t) Confirm by examination of the SSD that a failure analysis has been performed and documented. The results of the failure analysis and the possibility of continued safe operation of the ship are to be verified by testing a representative selection of failures.
 - u) Confirm by examination of the relevant certificate(s) that the Manufacturer complies with ISO 9000 Series Standards.
- Create an input error and ensure that immediate correction is required and that relevant guidance is given (see [4.1.5]).
 - Confirm by a performance check, conducted by suitably qualified personnel, that layered menus, if provided, are presented such as to minimise workload (see [4.1.6]).
 - If provided, ensure that multiple pages are uniquely identified and that an overview is available (see [4.1.7]).
 - Ensure that continuously displayed information and functional areas, e.g. menus, are presented in a consistent manner in multi-function displays (see [4.1.2], [4.1.8]).
 - Initiate a situation causing a potentially unintended result and ensure that the result is identified and that confirmation of the action is requested from the operator (see [4.1.9]).
 - Confirm by a performance check that completion of functions is acknowledged [4.1.10].
 - Confirm that there is an indication of configuration available at each workstation (see [4.2.1]).
 - Confirm that essential functions cannot be performed simultaneously at more than one workstation and that there is an indication of the configuration in use at each workstation (see [4.2.2]).

6.3.2 The Manufacturer is to produce a written statement that training possibilities are provided and confirm by examination of the training material that it covers general understanding and operation and mastering of uncommon conditions.

6.4 Technical requirements

6.4.1 The following tests are carried out:

- a) Confirm, as applicable, by examination of the SSD that sensors employed according to [5.1.1]:
 - communicate in accordance with IEC 1162
 - provide details of operational status, latency and validity of essential information
 - respond to a command with minimal latency and indicate receipt of invalid commands, when remote control is employed
 - have the capability to silence and re-establish the audible portion of the local alarm
 - have information documented about deterministic and stochastic errors and how they are handled.
- b) Initiate a situation identified in the SSD as requiring immediate reaction by an operator and confirm that the resultant alarm complies with IMO A.686 and A.830 (see [5.2.1]).
- c) Create conditions necessary to generate all types of alarms and indications listed in the matrix prepared in [6.2.2] a).
- d) Confirm that appropriate alarm management on priority levels and functional groups is provided and that the number of the alarm types and their release is kept as

6.3 Operational requirements

6.3.1 The following tests are carried out:

- Confirm by examination that the SYS-IBS includes displays, controls and instrumentation necessary to perform the functions identified in [6.2.2] a).
- Confirm by a performance check, conducted by suitably qualified personnel, that information presented is understandable without the need to transpose, compute or translate and that operation of integrated functions of the SYS-IBS identified in [6.2.1] is as effective as for equivalent stand-alone equipment (see [3.2.1], [4.1.1], [4.1.2]).
- Confirm by examination of the Manufacturer's SSD that the specific requirements in MSC/Circular 566, paragraphs 10 to 32, are met, if applicable.
- Confirm by a performance check that normal execution of functions and use of information are not accompanied by acoustic signals. If provided, ensure that acoustic signals accompanying attempts to execute an invalid function or use invalid information are short, of low intensity and clearly distinguishable from alarms.

low as possible by providing indications for information of lesser importance (see [5.2.2] [5.2.3]).

- e) Confirm that alarms are displayed so that the reason for the alarm and the resulting functional restrictions can be easily understood and that indications are self-explanatory (see [5.2.4]).
- f) Confirm that alarms are prioritised as emergency alarms, distress, urgency and safety alarms, primary alarms and secondary alarms (see [5.2.5]).
- g) Confirm by examination, performed by suitably qualified personnel, that:
 - a multi-function display is a colour display (see [5.3.1])
 - the size, colour and density of text and graphic information displayed on a VDU are such that it can be easily read from the normal operator position under all operational lighting conditions (see [5.3.2])
 - symbols used in mimic diagrams are standardised throughout the system's displays (see [5.3.3])

- all information is presented on a background providing high contrast and emitting as little light as possible at night (see [5.3.4]).
- h) Perform an orderly shutdown of the SYS-IBS and confirm that when power is turned on again, the default state specified in the SSD is reached (see [5.4.1]).
- i) Record the configuration in use and the recovery times of all subsystems. Disconnect all external sources of power and wait for expiration of the SYS-IBS transitional source of power. Restore power and wait for recovery of all subsystems. The recovery times of all subsystems are to be as recorded (see [5.4.2]).
- j) The **SYS-IBS** is to come to the configuration in use and continue automated operation as far as practicable. Verify that safety related automatic functions are continued only after confirmation (see [5.4.3]).
- k) Confirm by examination of the SSD that provision is made to comply with the power supply requirements listed in Tab 2 and in the matrix prepared in [6.2.2] a).

Table 2 : Power supply requirements in addition to the main source of energy

	Reserve source of energy (2)	Transitional source (1)	Emergency source (1)
Integrated bridge system		X (3)	X
VHF voice and DSC	X (4)		X (5)
MF voice and DSC	X (6)		X (7)
MF/HF voice, DSC and telex	X (6)		X (7)
INMARSAT ship earth station	X (6)		X (7)
NAVTEX receiver			
EGC receiver			
EPIRB	X (8)		X (8)
AIS transponders			X (9)
Aeronautical VHF SAR voice transceiver			X (10)
Lighting for radio installation (11)	X (12)		X
Equipment providing inputs to the radio installation	X (13)		X
Internal communication equipment and signals required in an emergency		X (14)	X
Magnetic compass and repeaters			X (9)
ECDIS or automatic graphical position display			X (9)
Electronic position fixing system	X (13)		X (9)
Radar			X (9)
Gyrocompass and repeaters			X (9)
Echo sounder			X (9)
Speed and distance log			X (9)
Rudder angle indicator			X (9)
Propeller rpm, thrust direction and pitch as applicable			X (9)
Heading control system			X (9)
Rate of turn indicator			X (9)
Voyage data recorder			X (9)

	Reserve source of energy (2)	Transitional source (1)	Emergency source (1)
Integrated navigation system			X (9)
Fire detection and alarm system		X (14)	X
Fire door holding and release		X (15)	X
Daylight signalling lamp, ship's whistle and manually operated call points		X (14)	X
Emergency lighting and navigation lights		X (14)	X
Fire pump			X
Automatic sprinkler pump			X (15)
Emergency bilge pump and remote controlled bilge valves			X (15)
Steering gear			X
Power-operated watertight doors and associated control, indication and alarm circuits		X (15)	X (15)
Lift cars			X (15)
Machinery alarm system (16)			X
Alarm transfer system for one person operated bridge (17)			X
<p>(1) Emergency and transitional sources are defined in SOLAS II-1/42 and /43. Where the emergency source is an accumulator battery, a transitional source of emergency electrical power is not required, unless otherwise stated.</p> <p>(2) Reserve source for radio installations is defined in SOLAS IV/13.</p> <p>(3) A transitional source is required for essential functions of the SYS-IBS (5.5.3).</p> <p>(4) Reserve source is required by SOLAS IV/13.2 for the installation to SOLAS IV/7.1.1.</p> <p>(5) Emergency source is required by SOLAS II-1/42.2.2.2 and 43.2.3.2 for installations as per SOLAS IV/7.1.1, 7.1.2 and 7.1.5.</p> <p>(6) Reserve source is required by SOLAS IV/13.2 for the installation to SOLAS IV/9.1.1, 10.1.1, 10.2.1 and 11.1 as appropriate for the sea area(s) for which the ship is equipped.</p> <p>(7) Emergency source is required by SOLAS II/1/42.2.2.2.1, 42.2.2.2.2 and 42.2.2.2.3 and 43.2.3.2.1, 43.2.3.2.2 and 43.2.3.2.3 for installations as per SOLAS IV/9.1.1, 9.1.2, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2 and 11.1 if applicable.</p> <p>(8) If position input provided from external equipment.</p> <p>(9) Local distribution panel(s) are to be arranged for all items of electrically operated navigational equipment. Each item is to be individually connected to its distribution panel. The power supplies to the distribution panel(s) are to be arranged with automatic change-over facilities between the main and the emergency source (IACS UR N1).</p> <p>(10) If not equipped with primary batteries.</p> <p>(11) Required by SOLAS IV/6.2.4.</p> <p>(12) Reserve source may be used (SOLAS IV/13.5) as supply independent from main and emergency sources.</p> <p>(13) Reserve source may be used (SOLAS IV/13.8) for ship's navigational or other equipment which needs to supply uninterrupted input of information to the radio installation to ensure its proper performance as required by SOLAS IV.</p> <p>(14) For cargo ships a transitional source is not required if the emergency source is a generator which can be automatically started and supply the required load within 45 s (see also (1)).</p> <p>(15) Required for passenger ships only (see also (1)).</p> <p>(16) A standby power supply with automatic change-over from normal power supply is required by SOLAS II-1/51.2.1.</p> <p>(17) A standby power supply with automatic change-over from normal power supply is required by IACS UR N1.</p>			

SECTION 3 COMMUNICATION SYSTEM (SYS-COM)

1 General

1.1 Application

1.1.1 The additional class notation **SYS-COM** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.5.4], to ships fitted with a communication system complying with the requirements of this Section.

1.1.2 The aim of this notation is to obtain a safe communication tool which provides:

- the user ashore with the possibility of having a complete overview of the ship situation (voyage, cargo and machinery)
- the personnel on board with the possibility of calculation, consultation of databases available ashore and assistance from specialised troubleshooters ashore.

2 Documentation

2.1 Documents to be submitted

2.1.1 In addition to the documents mentioned in Pt C, Ch 3, Sec 1, Tab 1, and the requirements in Pt C, Ch 3, Sec 1, [2.1.1], documents according to Tab 1 are to be submitted.

3 Design requirements

3.1 General

3.1.1 Permanent and reversible communication between ship and shore is to be available.

3.1.2 The collection of data on board is also to be permanently activated, at an acceptable speed for the planned application of transmission.

3.1.3 Transmission protocol is to be according to a recognised international standard, such as the National Marine Electronic Association and international marine interface Standard IEC 1162.

3.2 Content of data transmitted

3.2.1 The Standard N×ISO 10303, New Work Item N684, still being developed, provides the nature of information which could be transmitted. This notation states a minimum list of data to be transmitted. Complementary data obtained from the Standard could be required by the Owner.

3.2.2 At least the following permanent updated information is to be available:

- machinery data
- cargo data
- navigation data
- cost data including bunkering
- access to databases.

3.2.3 Machinery data is to include at least:

- alarm and monitoring of the complete machinery of the ship (which leaves the possibility of remote trouble shooting or specific analysis to improve the global efficiency of the ship)
- Spare parts needs (enabling the ordering of the necessary spares in advance and the preparation for delivery on board)
- Availability of spares or components on board and ashore.

Table 1 : Documentation to be submitted

No.	I/A (1)	Documentation
1	A	Diagram of local area network and hardware characteristics
2	A	Diagram of computer network and hardware characteristics
3	A	Communication software description of local area network (Protocol characteristics...)
4	A	List of data to be transmitted on internal network and priority level
5	I	Specifications of the external communication systems
6	A	List of data to be transmitted on external network and priority level
7	A	Communication software description of external network including software in receiving station ashore (Protocol characteristics...)
8	A	Test program of the communication equipment including test method for the integration of all the communication equipment (additional to the test procedure for type approval)
(1) A : to be submitted for approval I : to be submitted for information.		

3.2.4 Cargo data, as a minimum, is to include according to the ship's service:

- for container ships, the identification and the "history" of containers on board
- for gas carriers, the level and volume of cargo remaining on board
- for refrigerated container ships, the "history" of the cargo in containers
- for tankers, the level and volume of cargo on board.

3.2.5 Navigation data, as a minimum, is to include:

- the situation of navigation (position of the ship, local weather indication, sea conditions)
- navigation plan (indication of planned routes).

3.2.6 Cost data, as a minimum, is to include:

- the balance of the costs on board (accounting situation)
- the bunkering situation (enabling decisions to be made on the location of bunkering and the possibility of negotiating the cost and quality of the bunker).

3.2.7 Access to the database ashore is to be available. The data to be transmitted can be of great diversity and are only to be dedicated to the exploitation of the ship.

3.3 Transmission safety

3.3.1 Corrupted data are not to be accepted. Corrupted or missing data are not to affect functions which are not dependent on this data.

3.3.2 All data are to be identified with a priority level. The transmission software is to be designed so as to take into consideration the priority of data.

3.3.3 All transmission equipment is to be duplicated or have a secondary means which is capable of the same transmission capacity, with automatic commutation from one to the other in the event of failure.

3.3.4 An alarm is to be triggered in the case of automatic commutation due to failure, indicating which transmission equipment is affected.

3.3.5 A failure analysis is to be carried out to identify the reliability of the transmission system. This analysis is to include the duplicated components or software.

4 Construction requirements

4.1 General

4.1.1 Communication equipment is to comply with the requirements stated in Part C, Chapter 3.

4.1.2 The communication equipment for the SYS-COM notation is to be of an approved type.

4.1.3 The communication equipment is to be designed and produced according to a quality assurance scheme, with reference Standard ISO 9000-1, and is to be surveyed by the Society.

5 Testing

5.1 Design validation

5.1.1 The validation of conception of the communication system includes:

- internal communication (coherence of internal network, "INTRANET", local area network LAN) which is used for the alarm, control and safety systems
- internal communication of all computers used for management operation (maintenance, cargo, cost control), which are to be internally networked on the ship
- external communication (safety of ship, navigational aids, remote reporting of ship status for maintenance and operational purposes ashore), with SATCOM, radio-telephone, radio
- compatibility of the components and software.

5.2 Product type approval

5.2.1 Type approval of products involved in the function of communication, hardware and software is to be carried out prior to installation. This is to cover the following:

- external communication using satellite communication equipment, radio equipment, radio telephones, automatic telephones
- internal communication using LAN communication nodes and associated software, standard communication cards and associated software for PC applications
- cables for networks
- antennas
- association and compatibility of the above components.

5.2.2 The type approval procedure and tests are to be carried out according to Pt C, Ch 3, Sec 6.

5.3 Shipboard testing

5.3.1 The means of transmission (hardware and software) are to be checked when installed. This includes:

- the proper use of the approved components
- the correct installation on board the ship, which takes into consideration the hardware (cabling, location of aerials, layout of consoles) and the software (compatibility of assembled software, the man-machine interface)
- the proper function verified with appropriate tests. The tests of transmission equipment are to be carried out according to ISO 9646.

Part F
Additional Class Notations

Chapter 5

MONITORING EQUIPMENT (MON)

SECTION 1 HULL STRESS AND MOTION MONITORING (MON-HULL)

SECTION 2 SHAFT MONITORING (MON-SHAFT)

SECTION 1

HULL STRESS AND MOTION MONITORING (MON-HULL)

1 General

1.1 Application

1.1.1 The additional class notation **MON-HULL** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.6.2] to ships equipped with a Hull Stress and Motion Monitoring System (hereafter referred to as Hull Monitoring System for easy reference), complying with the requirements of this Section.

1.1.2 A Hull Monitoring System is a system which:

- provides real-time data to the Master and officers of the ship on hull girder longitudinal stresses and motions the ship experiences while navigating and during loading and unloading operations in harbour.
- allows the real-time data to be condensed into a set of essential statistical results; the set is to be periodically updated, displayed and stored on a removable medium. The information to be stored may be selected in view of later exploitation by the Owner, for instance as an element in the exploitation of the ship or as an addition to its logbook.

Note 1: The information provided by the Hull Monitoring System is to be considered as an aid to the Master. It does not replace his own judgement or responsibility.

1.2 Documentation

1.2.1 The following documents are to be submitted to the Society for approval:

- specification of the main components: sensors, processing units, display unit, storage unit, power supply and cabling
- functional scheme of the system
- principles and algorithm used for the data processing
- determination of measurement ranges
- determination of data limits
- calibration procedure including calibration values and tolerances.

1.3 Data limits, warning levels

1.3.1 The information provided by the transducers is to be compared against limits corresponding to maximum values obtained from the requirements on the basis of which the hull structure is approved.

These limits cannot be crossed and their approach is to be signalled to the crew in order for a corrective action to be carried out.

1.3.2 The above information and the related statistics can also be compared against warning levels determined by the Owner.

These warning levels are always to be less than the maximum values obtained from the requirements on the basis of which the hull structure is approved.

When a warning level is reached, a signal is to be emitted, different from the signals for the limits mentioned in [1.3.1].

2 Hull monitoring system

2.1 Main functions

2.1.1 The Hull Monitoring System is to be able to ensure the following main functions:

- collection of data
- data processing: scaling, consistency checking, statistical processing
- display management, handling of alarms and warnings
- selection, compression, if any, and storage of the results.

Note 1: The resources needed for the later onshore exploitation of the recorded results need not be considered as part of the Hull Monitoring System, provided that they cannot access the storage medium in order to modify the content.

2.2 Sensors

2.2.1 The sensors are to consist of a set of devices able to provide at least:

- information on the longitudinal stresses in the main deck, at least at one location where the maximum hull girder normal stress can be expected during navigation, loading and unloading.

For a more consistent monitoring of the loading and unloading operations, information on longitudinal stresses in still water is to be collected in way of each cargo hold.

- information on the vertical acceleration at the bow.

For a consistent monitoring of the vertical acceleration in any point of the hull girder, acceleration is also to be collected at the stern.

- information on the transverse acceleration due to the roll and to the heel.

2.2.2 Attention is drawn to the possible existence of local strains induced by temperature gradients in the hull structure.

The strain sensors are to be located in areas free from these temperature gradients.

If a temperature compensation device is implemented, the Manufacturer is to demonstrate its effectiveness on site.

2.2.3 The sensors are to comply with the applicable requirements concerning protection against conducted and radiated electric and radioelectric emissions.

2.2.4 The sensors are to be selected and installed in such a way that a periodical on-site recalibration can be carried out without extra equipment.

When this operation is impossible, the Manufacturer is to declare the period and procedure for the bench test calibration and demonstrate that the initial calibration remains valid within the period.

2.3 Specifications

2.3.1 For each type of measurement, the Manufacturer is to state the limits of the domain, according to the ship.

The limits are to include:

- the strain ranges
- the acceleration ranges
- the corresponding frequency range
- the temperature ranges: sea water, open air, hull structure, sheltered, accommodation.

2.3.2 The global resolution of the instrument is to be such that the uncertainty as to the displayed information is less than 7% of its full scale display. The global resolution applies on the entire domain; the specification of the components is to be set accordingly.

2.3.3 The system is to be able to detect and signal the malfunctions which can impair the validity of the data, e.g.:

- data are out of range
- data remain strictly constant
- data are corrupted by high intensity noise
- the system stops or hangs.

2.4 Data processing

2.4.1 Wave-induced data are to be processed through a cyclical statistical procedure; the procedure (maximum peak value, RMS, mean value, frequency spectrum, etc.) is to be selected in order that the displayed information is significant, not confusing, immediately understood and as close as possible to the nautical experience of the crew.

The procedure is to produce smoothed results that are not to deviate by more than 10% from one cycle to the next when in steady navigation conditions.

The procedure is to be such that a significant change in the navigation conditions appears on the display after no more than three cycles.

The system is to switch automatically from port to sea conditions, and vice versa.

2.4.2 It is recommended that the Hull Monitoring System should be linked to the loading instrument for a secure transfer of information from the instrument to the system.

This arrangement is to allow for the actual still water hull girder stresses, converted to longitudinal bending moments,

as issued by the system, to be compared against the predicted values from the loading instrument.

2.4.3 Provision is to be made for a connection with a Voyage Data Recorder where this is fitted on board. The Manufacturer is to declare a limited set of parameters to be forwarded to the Voyage Data Recorder.

2.5 Visual display

2.5.1 A graphical display is to be fitted, with the following features:

- it is to be simple, clear and non-confusing
- the user is to be able to obtain the information through one reading
- it is to be readable at a distance of at least 0,5 m
- two major pieces of information (e.g. stress and vertical acceleration at bow) are declared as "default conditions" and displayed at power up and in the absence of keystroke from the user
- when an alarm is emitted, the corresponding information is to be displayed instead of the above "default conditions".

2.5.2 When the system detects a malfunction, the corresponding status is to be superimposed on the display.

2.6 Alarms

2.6.1 For each limit stated in [1.3.1], visual and audible alarms are to be fitted on the bridge to indicate when the limit is approached and exceeded.

The alarms associated with each limit are to be clearly distinguishable from those relevant to other limits.

2.6.2 When a warning level is reached (see [1.3.2]), a visible signal is to be issued, distinct from those of the alarms for limits stated in [2.6.1].

2.6.3 When the system detects a malfunction, the alarms and warnings associated with the data are to be inhibited and a malfunction alarm is to be issued (see also [2.5.2]).

2.7 Data storage

2.7.1 The data are to be stored either by a recording device which is part of the Hull Monitoring System, according to [2.7.2] to [2.7.4], or by the integrated bridge system, if any.

2.7.2 An electronic data storage recording device suitable for accumulating statistical information for feedback purposes is to be fitted.

2.7.3 The data storage recording device is to be:

- entirely automatic, excluding replacement operations of the storage support
- such that its operation does not interrupt or delay the process of collecting and treating data.

2.7.4 Data are to be recorded with information on the date and time.

2.8 Exploitation and checking of stored data

2.8.1 The data stored according to [2.7] are to be treated by the Owner through a statistical process.

2.8.2 Periodicity of exploitation of data is to be defined by the Owner depending on the ship's operation.

2.8.3 Means are to be incorporated which ensure that the integrity of the collected data can be checked at the exploitation stage.

2.9 Power supply unit

2.9.1 The Hull Monitoring System is to be powered by the main power source of the ship and in addition with an internal uninterruptible 30 minute power source.

2.10 Calibration

2.10.1 The initial calibration of the Hull Monitoring System is to be based on an approved loading case in still water.

The differences between results obtained from the Hull Monitoring System and approved values are to be less than 5%.

2.10.2 The initial calibration of the Hull Monitoring System is to be carried out with a Surveyor in attendance.

2.11 Periodical inspections

2.11.1 Checks of the main functions of the Hull Monitoring System are to be carried out at intervals as agreed by the Society and not exceeding one year.

The instrument is to include an auto-checking facility so that the verification of the Hull Monitoring System can be carried out without the need of external devices.

SECTION 2

SHAFT MONITORING (MON-SHAFT)

1 General

1.1 Applicability of MON-SHAFT notation

1.1.1

The additional class notation **MON-SHAFT** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.6.3], to ships complying with the requirements of this Section.

1.1.2 This notation is assigned only to ships having tailshafts arranged with oil lubricated stern bearing and with approved oil sealing glands.

1.1.3 The assignment of this notation allows a reduced scope for complete tailshaft surveys; see Pt A, Ch 2, Sec 2, [8.3.1].

2 Requirements for the issuance of the notation

2.1 Arrangement

2.1.1

In order for the notation **MON-SHAFT** to be granted, the stern bearing is to be arranged with:

- facilities for measurement of bearing wear down,
- at least one temperature sensor for the aft bearing giving temperature indication and high temperature alarm; an alarm is to be activated in the event of failure of the temperature sensor circuit.

2.2 Lubricating oil analysis

2.2.1 Item to be monitored

In order for the notation **MON-SHAFT** to be granted, the lubricating oil of the stern bearing is to be analysed as indicated in this Section.

2.2.2 Timing

Stern bearing lubricating oil is to be analysed regularly; in any event, the interval between two subsequent analyses is not to exceed six months.

2.2.3 Records

The lubricating oil analysis documentation is to be available on board showing in particular the trend of the parameters measured according to [2.2.4].

2.2.4 Content of analysis

Each analysis is to include the following parameters:

- water content
- chloride content
- bearing material and metal particle content
- oil ageing (resistance to oxidation).

The oil samples are to be taken under service conditions and are to be representative of the oil within the sterntube.

2.2.5 Additional data to be recorded

In addition to the results of the oil sample analysis, the following data are to be regularly recorded:

- oil consumption
- aft bearing temperature.

COMFORT ON BOARD AND IN PORT AREA (COMF)

SECTION 1	COMFORT WITH REGARD TO NOISE ON BOARD SHIPS
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SECTION 1

COMFORT WITH REGARD TO NOISE ON BOARD SHIPS

1 General

1.1 Application

1.1.1

COMF-NOISE notation, in accordance with Pt A, Ch 1, Sec 2, [6.7.2], is assigned to ships classed by the Society and complying with the requirements of this Section.

In the event that the ship undergoes modifications, refitting or repairs that may affect its level of comfort, the maintenance of the notation is subject to the results of new measurements as deemed appropriate by the Society.

The notation is completed by a letter **A**, **B** or **C** which represents the merit level achieved for the assignment of the notation, the merit **A** corresponding to the lowest level of noise.

The notation **COMF-NOISE** is only assigned if at least merit level **C** is reached.

When the merit levels achieved for the passenger spaces (if any) and the crew spaces are different, the notation is completed by the suffix:

- **PAX**, for passenger spaces, and
- **CREW**, for crew spaces.

1.1.2

Ships not classed by the Society complying with the requirements of this Section are provided with a Certificate of Conformity which attests their comfort quality. The Certificate is valid for a period of 5 years and may be extended, at the request of the Owner, for an additional 5-year period based on a limited set of measurements covering at least 5% of those made when the Certificate was first issued.

1.1.3

The requirements apply to conventional passenger and cargo ships irrespective of the ship's age, as far as reasonable and practicable, to the satisfaction of the Society.

For ships less than 65 m (length between perpendiculars), special consideration will be given by the Society, in particular concerning the requirements in [5].

1.1.4

Comfort noise notations for crew spaces are equivalent to the noise level limits stated in IMO Resolution MSC.337(91) as follows:

- **COMF-NOISE CREW A** for ships with gross tonnage equal to or greater than 10,000 GT
- **COMF-NOISE CREW B** for ships with gross tonnage from 1,600 GT up to 10,000 GT

For ships not subject to the application of IMO Resolution MSC.337(91), **COMF-NOISE CREW C** may be assigned.

1.2 Basic principles

1.2.1

The requirements of this Section define the limits of acceptability of noise on board, the methods for verification of compliance and the criteria for acceptance. They are based, as appropriate, on international standards and are deemed to preserve the general principles of such standards.

1.2.2

Verification of compliance is based on the measurements of noise levels in ship spaces and of the insulation characteristics of barriers as specified in [3.2]. These measurements are to be carried out either by a Surveyor of the Society or by a technician from a company recognised as suitable by the Society. In the latter case, measurements are to be performed under the surveillance of a Surveyor of the Society.

2 Definitions

2.1 Categories of spaces

2.1.1 General

For the purposes of this Section, a specific, comfort-related categorisation of the ship spaces is used.

2.1.2 Crew spaces

Crew spaces are defined according to Resolution MSC. 337.

2.1.3 Passenger spaces (1/1/2021)

With the exception of garages, washrooms and toilets, to which the requirements of this Section do not apply, passenger spaces are the following:

a) Standard cabins

Spaces for private use of the passengers, where the primary purpose is to rest.

b) Suites or mini-suites

Luxury finish cabins greater than 15m² with private lounge area with an extension at least 30% of the total surface.

c) Cabin with communicating door

Cabin that has a communicating door on a common wall to another cabin.

d) Type A entertainment spaces

Enclosed spaces for passenger recreation and/or prolonged passenger stay where the noise level is normally high when in use (e.g. discos, theatres, cinemas, casinos, show rooms, etc.).

e) Type B public spaces

Enclosed spaces for passenger recreation and/or prolonged passenger stay where the noise level is not nor-

mally high when in use (e.g. self service restaurants, main restaurant, pullman seat rooms, lounge areas, bars, gymnasiums, conference halls and similar spaces, etc.).

Self-services restaurants and main restaurants with hoods or open kitchen are to be considered both as a passenger space (type B public space) and as a crew space (galley) with hoods operating.

f) **Type C public spaces**

Enclosed spaces for passenger recreation and/or prolonged passenger stay where the noise level is low (e.g. reading rooms, libraries, card rooms, chapels, special restaurants, health centre, sitting rooms, small lounges and similar spaces, etc.).

g) **Type D public spaces**

Spaces where passengers are not normally expected to stay long (e.g. shops, enclosed walkways, atriums, passenger laundrettes, halls and similar spaces, etc.).

h) **Type E transit spaces**

Spaces where passengers are normally expected to stay for a short period of time (e.g. corridors, stairs, etc.).

i) **Type F open spaces**

Outside spaces for prolonged and/or recreational stay of passengers (e.g. swimming pool area, jacuzzi area, open walkways, sun decks, etc.).

2.1.4 Work Spaces

Service spaces (such as galleys, serveries, pantries, technical spaces, workshops, passageways etc.) with significant random noise levels or potential high noise levels above 85dBA.

2.2 Noise

2.2.1

Noise is the audible sound wave level, generally of a random nature, in the 20 to 18000 Hz frequency range. As far as compliance with the requirements of this Section is concerned, noise is measured in the 31,5 to 8000 Hz frequency range unless otherwise specified by the Society in special cases.

2.2.2

For the purposes of this Section, A-weighted noise levels are considered, measured in dB(A) by a precision sound level meter with an accuracy grade of about ± 1 dB.

2.3 Operational power in the CSR condition

2.3.1

Operational power is the propulsion power, in kW, at which the ship is normally operated.

2.3.2

The operational power to be considered for the purpose of these Rules is 85% of the maximum continuous rate (MCR) defined in the following as the continuous service rate (CSR) condition.

Controllable pitch and Voith-Schneider are to be in normal seagoing position.

2.3.3

Subject to the acceptance of the Society and to the agreement of the Owner and shipyard, a propulsion power at CSR other than 85% MCR is to be used, if such condition corresponds to the normal seagoing conditions.

2.4 Sound Index

2.4.1 Sound Reduction Index (R_w)

According to EN ISO 717-1:2013 and EN ISO 10140-2:2010, R_w is the laboratory measurement of individual airborne sound insulation of building elements.

2.4.2 Apparent Sound Reduction Index (R'_w)

According to EN ISO 717-1:2013 and EN ISO 140-4:1998, R'_w is the value of field measurements of total airborne sound insulation between rooms.

Field measurements should be performed according to ISO 140-4:1998. When the area of the material tested is < 10 m², a minimum value of 10 m² should be considered for the calculation of the R'_w index.

2.5 Impact Sound Index ($L'_{n,w}$)

2.5.1

According to EN ISO 717-2:2013 and EN ISO 140-7:1998, $L'_{n,w}$ is the value of field measurements of the impact sound index of floors and ceiling assembly.

3 General requirements

3.1 Design requirements

3.1.1 Noise insulation characteristics of barriers

For the purpose of the requirements of this Section, the noise insulation characteristic of the divisions formed by walls, ceilings and floors is represented by the R'_w , which is measured in dB.

Depending on the types of spaces separated by divisions (vertical and horizontal), the R'_w is to be at least as given in Tab 1.

The individual noise insulation characteristic (R_w) of cabin divisions is to be selected as appropriate. It is recommended that the R'_w of all surfaces be considered during design, e.g. when carrying out the noise prognosis [3.1.4].

3.1.2 Impact Sound Index characteristics of floor and ceiling combinations

For the purpose of the requirements of this Section, the impact sound insulation characteristic of a floor/ceiling combination is represented by the $L'_{n,w}$, which is measured in dB.

Depending on the types of floors above cabins, the minimum values of $L'_{n,w}$ are provided in Tab 2.

For the purposes of Tab 2:

- soft floor is carpet, moquette and similar
- hard floor is marble, tiles, wood, resins and similar.

Table 1 : Noise insulation characteristics of the divisions

Division between:	R' _w (dB)		
	A level	B level	C level
• Suite or mini-suite / cabin (1)	43	40	35
• Standard cabin / cabin (1)	40	37	35
• Disco / cabin	65	60	55
• Type A spaces / cabin	60	55	50
• Type B spaces / cabin	55	50	45
• Type C spaces / cabin	50	45	40
• Type D spaces / cabin	50	45	40
• Corridors (Type E spaces) / suite	40	35	33
• Corridors (Type E spaces) / cabin	37	33	30
• Crew Cabin/ Accommodation spaces	45	45	42
• Crew cabin/crew cabin	35	35	32
• Crew cabin/corridor	30	30	27
(1) Except for Cabin suite / cabin with communicating door where the R' _w limits are reduced by 3dB			

Table 2 : Impact Noise Insulation characteristics of floor

Floor above cabin	L' _{n,w} (dB)
• Soft floor	50
• Hard floor	55
• Dance floors, stages, gymnasium floor	45

3.1.3 Acoustic insulation plan

The acoustic insulation plan is a general arrangement plan of the spaces considered in this Section where the following information is provided:

- the types of space according to the categories given in [2.1];
- the value of the noise insulation characteristic (R_w) of cabin walls and floors;
- the values of the impact sound index (L'_{n,w}) above cabins;
- any type of acoustic insulation, even if integrated with the fire and thermal insulation plan.

3.1.4 Noise design prognosis

A noise design prognosis is a forecast based on calculation models, carried out at the design stage, of the expected noise levels in the ship spaces.

Although a noise design prognosis is not required to be submitted, it is recommended that it should be carried out by the Designer, in particular for passenger ships, in order to properly design the noise insulation system and to evaluate

appropriate values of R_w of floors, bulkheads and ceilings of cabins.

3.2 Construction requirements**3.2.1 Noise measurement plan**

A plan is to be prepared describing the proposed noise measurement campaign developed in compliance with [5.2]. The plan is to include the extension and classification of ship zones with the noise limit level with reference to the expected COMFORT level in compliance with [5.5] and the proposed minimum number of measurements to be taken in each ship space. The aim is to obtain a rational distribution of measurement points throughout the ship.

3.2.2 Noise measurement report

In accordance with [8], the report is to contain:

- position of measurements points
- measured noise levels according to [5]
- resulting global comfort level according to [7].

Furthermore, the following general data are to be recorded and included in the report:

- ship loading condition
- propulsion machinery details
- estimated water depth
- estimated environmental conditions (wind and waves)
- presence of noise sources due to external factors such as additional personnel, ongoing repairs or fitting work, etc;
- values of measurements of R'_w and L'_{n,w}, if applicable.

4 Documentation to be submitted**4.1 Acoustic insulation plan****4.1.1**

The acoustic insulation plan is to be submitted for information as soon as available and well before the execution of the measurement campaign. Although the acoustic insulation plan is not subject to approval, its submission is a necessary prerequisite for compliance with the requirements of this Section.

4.2 Noise Insulation characteristics**4.2.1**

The following information is to be submitted:

- For divisions delimiting cabin spaces:
 - Laboratory test certificate of sound reduction index R_w for each type of division installed on board
 - Installation details of all panels and outfitting for walls and ceilings
 - The apparent sound reduction index R'_w prediction of the on site values in the measurement points specified in [6.1]
- For floors and ceilings of cabins:
 - Impact Sound Index L'_{n,w} prediction of the on site measured values as specified in [6.1].

4.3 Measurement plan

4.3.1

The proposed measurement plan, developed according to [3.2.1], is to be submitted for information well in advance of the measurement campaign.

4.4 Noise measurement results

4.4.1

A duly signed detailed report is to be submitted for approval. The format shown in item [8] is recommended.

The noise measurement report is to be witnessed by a representative of the Builder, the Owner, a representative of the company which carried out the measurements and the Society's Surveyor in charge of surveillance of the measurements.

5 Noise levels: testing conditions and acceptance criteria

5.1 Testing conditions

5.1.1 General

Noise levels are to be measured according to ISO 2923 in the conditions defined below. Different conditions may be accepted as equivalent at the discretion of the Society.

5.1.2 Equipment running during the tests

During measurements, all auxiliary systems, forced ventilation and air conditioning systems (HVAC systems) and hotel service systems are to be operating in normal service conditions; as noise arising from every kind of unnecessary human activity is to be avoided, in general only the personnel needed for the operation of the ship hotel activities and those carrying out the measurements are to be present.

During measurements all passenger entertainment systems are to be switched off.

Doors and windows are to be closed.

The rooms are to be fully equipped with furniture, furnishings, ceiling and actual deck covering (e.g. carpet, etc.).

5.1.3 Ship loading conditions

As far as practicable the ship loading conditions are to be as close as possible to the normal operating conditions.

5.1.4 Environmental conditions

Water depth is to be at least 10 times the medium ship draught. In general, meteorological conditions are to be within the following limits:

- wind: not stronger than Beaufort 4 - strong breeze (speed 11 to 16 knots),
- waves: significant height 0,5 to 1 m.

5.1.5 Propulsive Power

- a) Measurements are to be carried out with the ship at the operational power in the CSR condition in [2.3].
- b) Additional measurements are to be carried out at 100% MCR and at x% MCR, the different propulsion power with respect to CSR is subject to the acceptance of the Society and to the agreement of the Owner and ship-

yard. In the case of ships with dynamic positioning, measurements are to be carried out at 40 % of maximum thruster power for the design environmental conditions that the ship operates in.

5.1.6 Other equipment

Subject to the acceptance of the Society and to the agreement of the Interested party, equipment such as bow thrusters, stabilising fins etc. is to be operating during measurements if it is necessary for the ship in normal operating conditions and in the environmental conditions specified in [5.1.4].

With the above-mentioned equipment operating, special consideration may be given by the Society concerning the acceptable noise level as per [5.5].

5.1.7 Accepted testing conditions (1/1/2021)

In open spaces in the aft area, the following additional measurements may be taken to compensate the noise generated by unavoidable natural sources (such as wake, wind, etc.):

- measurement with the vessel at 0 speed, and
- measurement with all necessary equipment running for transit condition.

The comfort level is to be calculated using the minimum sound pressure level between the value at 0 speed and in transit condition.

5.2 Measurement positions

5.2.1 General

Measurements are to be carried out in the most representative spaces defined in [2.1] close to the potential noise sources (engine casing, ventilation trunk, HVAC station, machinery room, outlet fan, etc.) according to the following principles.

At the discretion of the Society, additional measurements are to be performed to establish the extension of area with excessive noise levels.

In the assessment of the noise distribution, for all types of enclosed spaces, only the points with an average value representative of an area larger than 50 m² will be considered.

If a noise level difference greater than 5 dB(A) exists in the same enclosed space, additional measurements in that space are to be considered.

When measuring noise levels close to intake and exhaust openings, the microphone should, where possible, not be placed within a 30° angle away from the direction of the gas stream and not less than a distance of 1 m from the edge of the intake or exhaust opening of engines, ventilation, air conditioning and cooler systems, and as far as possible from reflecting surfaces according to ISO 2923.

5.2.2 Passenger spaces

a) Cabins, mini-suites and suites

Measurements are to be carried out, based on the measurement plan, in at least the most representative 30% of the cabins located between the stern and the forward bulkhead of the engine room and in the most representative 10% of the other cabins. The microphone position

is to be located in the middle of the cabin at a height of 1.4 m from the deck. No microphone positions are to be closer than 0,5m from the boundary surface of the space.

Each tested cabin larger than 25 m² is to contain at least two measurements points, each point at 1/3 of the main dimension. At the discretion of the Society, additional measurements are to be carried out.

Only the average noise will be considered in the comfort level assessment of the cabin.

b) **Enclosed passenger spaces (Type A, B, C, D and E spaces)**

Measurements are to be carried out in all such spaces with an extension larger than 150 m².

One measuring point is to be placed (approximately) every 100 m² of area of the space under examination.

Spaces with an area smaller than 150 m² are to be considered only if close to potential noise sources.

c) **Type F open spaces**

Measurements are to be carried out in all such spaces. In open recreational spaces, if designed for prolonged stay of passengers (e.g. swimming pool area), a measurement point is to be placed every 100 m². For other types of spaces a measurement point is to be placed every 200 m². If the open space can be closed by means of mobile elements, such space is to be considered an enclosed space and subject to the relevant requirements.

5.2.3 Crew and work spaces

Measurements are to be taken in at least:

- three points of the wheelhouse (one at the centre, one at the ends, port or starboard and one of the navigating bridge wing on the lee side of the ship)
- six cabins (including hospital) on each deck for each main vertical zone (preferably two cabins at the centre, and at the extremities two portside and two starboard side).
- one point in manned workspaces, closer than 1m from operating machinery, decks, bulkheads, air inlets. If it is not possible, the microphone should be in the middle between the machinery and adjacent reflecting surface. The microphone position is to be located at a height of between 1,2 m to 1,6 m from the deck, platform or walkway.
Measurements shall be taken at intervals not greater than 3m around all sources (e.g. main turbines or engines, main gearing, boiler firing platform, compressor).
- at local control stations, e.g. the main manoeuvring or emergency manoeuvring stand on the main engine and the machinery control rooms.
- in the workshops, in order to restrict the number of measurements and recordings, the number of recordings can be reduced to a total of at least four measurements at each machinery space level up to upper deck.

Any other surveyed space larger than 60 m² is to contain at least two measurement points.

5.3 Instrumentation

5.3.1

Noise level measurements are to be carried out by means of integrating-averaging sound precision level meters. These sound level meters are to comply with IEC 60942 (2003-01) or a standard accepted as equivalent by the Society.

This compliance is to be verified according to ISO 17025 (2005) at least every two years by an organisation recognised by the Society.

The date of last verification and confirmation of compliance with relevant IEC standards is to be recorded. Calibration sheets are to be provided.

5.4 Measurement procedure

5.4.1

Measurements are to be carried out to estimate the sound pressure levels L_p by averaging the noise level during at least 15s with the time-weighting slow (S). If the sound is irregular with fluctuations exceeding ± 3 dB(A), the measuring time is to be extended to at least 30s. The measured value is to be rounded to the nearest integer.

Noise level is to be measured in dB (A) units with the A-weighting curve.

A main vertical zone with excessive noise levels respect to the expected limit is to be subjected to additional measurements to highlight the extension of the spatial distribution of the noise.

The averaged space noise level, L_{Aeq} , representative of the COMFORT level of the space type is calculated on an energy basis according to the following equation:

- Space less than 150 m², L_{Aeq} is the average of the measured noise levels set for this space

$$L_{Aeq} = 10 \log \left(\frac{\sum_{i=1}^N 10^{\left(\frac{1}{10} L_{pi}\right)}}{N} \right)$$

- Spaces equal to or greater than 150 m², L_{Aeq} is the weighted average of the set of measured points taking into account the effective area covered with the single measured value

$$L_{Aeq} = 10 \log \left(\frac{\sum_{i=1}^N S_i 10^{\left(\frac{1}{10} L_{pi}\right)}}{\sum_{i=1}^N S_i} \right)$$

where:

- L_{pi} : noise level of i-th point
- S_i : area associated to the i-th noise level
- N : number of measurements

5.5 Acceptable noise levels in the CSR condition

5.5.1

Limits for the calculation of the noise comfort level are given in Tab 3, for each category of space.

For crew spaces on all types of ships the Society may accept different values depending on the national requirements of the State whose flag the ship is flying, provided that such values are not higher than L_B in Tab 3.

Table 3 : CSR condition - Noise limits levels

Type of space	L_A	L_B
Passenger spaces		
Suite or mini-suite (S)	45	50
Standard cabins (Cb)	50	55
Type A, B and D spaces	55	60
Type C spaces	52	57
Type E spaces	60	65
Type F spaces (1)	65	70
Crew spaces		
Crew cabins	55	60
Senior officer cabins	52	55
Navigation spaces / Radar room	65	65
Radio Room	60	60
Look-out posts, incl. navigating bridge wings and windows	70	70
Hospital	55	60
Public crew spaces	60	65
Work spaces without equipment operating	70	75
Workshops other than those forming part of machinery	85	85
Offices	60	65
Mess Room / recreation room	60	65
Engine Control Room	75	75
Crew open decks (2)	75	75
(1) +10 dB(A) if less than 1 m from the ventilation inlet/outlet		
(2) + 5 dB(A) if less than 1 m from the ventilation inlet/outlet		

5.5.2

For each measured space, the time-space averaged noise level, L_{Aeq} , calculated according to [5.4] is compared with the limits in Tab 4.

a) Noise level: passenger cabins and Type A, B, C, D spaces less than 150 m²

1) Comfort level is A if:

- all L_{Aeq} values are less than or equal to L_A , or
- all L_{Aeq} values are less than or equal to L_A , except for less than or equal to 5% of the total number of spaces of these types.

In any case, spaces with L_{Aeq} exceeding L_a are to be less than or equal to L_B .

2) Comfort level is B if:

- all L_{Aeq} values are less than or equal to L_B

3) Comfort level is C if:

- all L_{Aeq} values are less than or equal to $L_B + 5dB(A)$.

b) Noise level Type A, B, C, D, E, F spaces greater than 150 m²

1) Comfort level is A if:

- all L_{Aeq} values are less than or equal to L_A

2) Comfort level is B if:

- all L_{Aeq} values are less than or equal to L_B

3) Comfort level is C if:

- all L_{Aeq} values are less than or equal to L_B , except for less than 10% of the total number of these types of spaces on board, which are to be less than or equal to $L_B + 5dB(A)$.

c) Noise level crew spaces

- 1) Comfort level is A if:
 - all L_{Aeq} values are less than or equal to L_A ,
- 2) Comfort level is B if:
 - all L_{Aeq} values are less than or equal to L_B
- 3) Comfort level is C if:
 - all L_{Aeq} values are less than or equal to L_B , except for the senior officer cabins, which are to be less than or equal to $L_B + 5dB(A)$.

5.6 Noise levels at power other than the CSR

5.6.1 Measurement positions

The aim of these measurements is to verify that the noise levels do not change excessively. The measurements are to involve critical areas up to 5% of the total number of measurements on each deck taken at the CSR. Critical areas are those where highest noise levels have been measured.

Excluding outside recreational spaces, for each deck the areas in way of the longitudinal position of the propeller and close to the engine casing are to be considered critical.

5.6.2 Acceptable noise level in a condition other than the CSR

The measured noise levels in the operating condition of [5.1.5] b) L_{MCR} (noise level at MCR) and $L_{x\%MCR}$ (noise level at reduced power x% of MCR) are compared with the measured noise level at CSR, L_{Aeq} of [5.1.5] a).

- a) Comfort level is A if:
 - all differences of the noise levels with the corresponding values at CSR are lower than or equal to 3 dB(A),
 or
 - the noise levels are less than or equal to $L_A + 5$ dB(A).
- b) Comfort level is B if:
 - the noise levels are less than or equal to $L_B + 5$ dB(A).
- c) Comfort level is C if:
 - all differences of the noise levels with the corresponding values at CSR are greater than 5 dB(A).

6 Acoustic insulation characteristics: testing conditions and acceptance criteria

6.1 Testing conditions

6.1.1 General

Measurements also to be carried out in passenger cabins according to the following indications. At the discretion of the Society, additional measurements are to be carried out in particular locations within the measurement area.

Measurements are also carried out in crew spaces if the installation and assembly of barriers, ceiling, floors and acoustic insulation is different from passenger spaces.

The noise insulation characteristics of division (R'_w) and the impact noise characteristics of floors and ceilings ($L'_{n,w}$) are

to be measured only in cabin areas with the ship at berth once the installation of the walls, floors, ceilings and furnishings is complete.

6.1.2 Measurement positions (1/1/2021)

For each type of wall and deck division, measurements are to be taken for the cabin with the largest area separating measured spaces.

- a) For each type of vertical and horizontal division, measurements are to be taken of acoustic insulation from airborne noise index R'_{Wmis} .

R'_{Wmis} values are to be compared with the limits in Tab 1.

- b) For standard cabins and suites [2.1.3], below each kind of passenger space with different type of floor, measurements are to be taken of acoustic insulation from impact sound $L'_{n,Wmis}$.

Two types of floor are to be considered:

- hard: marble, wood, tiles
- soft: moquette, synthetic green.

For each kind of floor measured values are to be compared with the limits in Tab 2.

6.1.3 Measurement procedure

Measurements of acoustic insulation indexes from airborne noise and from impact noise are to be taken according to ISO Standards in [2.4] and [2.5].

6.2 Acceptance criteria

6.2.1

For each floor or wall measured according to [6.1.2] and with reference to the characteristic value of R'_w in Tab 1 and $L'_{n,w}$ in Tab 2, the resulting comfort level is:

A if:

- Acoustic insulation of vertical division R'_{Wmis} greater than or equal to R'_w at A level, and
- Acoustic insulation of horizontal division R'_{Wmis} between passenger cabin and type A spaces, greater than or equal to R'_w at A level, and
- Impact noise $L'_{n,Wmis}$ lower than or equal to L'_{nw}

B if:

- Acoustic insulation of vertical division R'_{Wmis} greater than or equal to R'_w at B level, and
- Acoustic insulation of horizontal division R'_{Wmis} between passenger cabin and type A spaces, greater than or equal to R'_w at B level

C if:

- Acoustic insulation of vertical division R'_{Wmis} greater than or equal to R'_w at C level, and
- Acoustic insulation of horizontal division R'_{Wmis} between passenger cabin and type A spaces, greater than or equal to R'_w at C level.

7 Global noise comfort level of the ship

7.1 General

7.1.1

The comfort level is rated on the basis of the actual rating reached by noise levels and acoustic insulation indexes, provided that at least C level is reached.

For the purposes of these Rules, the global noise comfort level is assigned as follows.

7.1.2 COMF-NOISE A

Comfort level is A, if:

- noise levels at the CSR in [5.5]
- conditions other than the CSR in [5.6]
- acoustic insulation indexes in [6.2]

are A level.

7.1.3 COMF-NOISE B

Comfort level is B, if one of the following:

- noise levels at the CSR in [5.5]
- condition other than the CSR in [5.6]
- acoustic insulation indexes in [6.2]

is B level (the others are to be A or B).

7.1.4 COMF-NOISE C

Comfort level is C, if one of the following:

- noise level at the CSR in [5.5]
- condition other than the CSR in [5.6]
- acoustic insulation indexes in [6.2]

is C level.

Note 1: In any case the three above-mentioned items are to be evaluated.

8 Report

8.1

8.1.1

The report for noise measurements is to contain the following Tables.

Table 4 : Characteristics of the ship

Name of the ship			
Register number - RI			
Flag			
Name and address of the Owner			
Name and address of the Shipyard			
Place of build			
IMO number			
Gross tonnage			
Construction number			
Type of ship			
Dimensions			
	Length - L	m	
	Breadth - B	m	
	Depth - D	m	
	Max. draught - T	m	
	Displacement at draught T	t	
Date of keel laying			
Date of delivery			
	Velocity at MCR	knots	
	Propulsion Power at MCR	kW	
	Propulsion Power at CSR	kW	%MCR

Table 5 : Characteristics of the machinery

Propulsion machinery		
	Manufacturer	
	Type	
	Number of units	
	Max. continuous power	kW
	Shaft speed	rev./min
Auxiliary diesel engines		
	Manufacturer	
	Type	
	Output	kW
	Number of units	
Main reduction gear		
Type of propeller		
	Number of propellers	
	Number of blades	
	Shaft speed at MCR	rev/min
	Propeller Diameter	m
	Propeller Pitch at MCR	
Controllable Pitch	YES	NO
Stabilising fins, bow thruster etc. needed for normal operation:	YES	NO
Other (special propulsion and power configurations)		
Engine room ventilation		
	Manufacturer	
	Type	
	Number of units	
	Fan Diameter	m
	Fan speed	rpm/variable speed (Y/N)
	Total pressure	Pa
	Airflow capacity	m ³ /h

Table 6 : Measuring instrumentation - noise

Instrumentation / Manufacturer	
Sound level meter	
Microphone	
Filter	
Calibrator	
Calibration of the sound level meter	
	Date of calibration in laboratory
	Date of calibration prior to measuring
Windscreen	
Other equipment	

Table 7 : Conditions during measurement

Date				
Starting time				
End time				
Position of the craft				
Type of voyage				
Conditions during measurement				
Draught forward		m		
Draught aft		m		
Depth of water under keel		m		
Weather conditions				
Wind force / speed		Bf - m/s		
Sea state / average wave height		SS - m		
		CSR	MCR	x%MCR
Speed of the ship	knots			
Propeller shaft speed	rev/min			
Propeller pitch setting				
Propulsion machinery speed	rev/min			
Propulsion machinery power	kW			
Percentage of the Maximum Continuous Rate	%		100	
No. of propulsion machinery units operating				
No. of generators operating				
No. of units of auxiliary machinery operating				

Table 8 : Measuring results: measurements at operational power - details

Position No.	Type of space: Cb: Std. Cabin; S: Suite or mini-suite; A, B, C, D, E, F; Crew Cb: Crew Std. Cabin; Crew S: Senior officer cabins ; Crew office, Crew workspace, Crew navigation Crew public	S [m ²]	L _p [dB(A)]	L _{Aeq} [dB(A)]	L _{x%MCR} [dB(A)]	L _{MCR} [dB(A)]
1						
2						
...						

Table 9 : Measuring results: measurements at operational power - summary

Total number of measurements		Total number of Spaces	
No. of measurements $\leq L_A$		% of measurements $\leq L_A$	
No. of measurements $\leq L_B$		% of measurements $\leq L_B$	
No. of measurements $\leq L_B + 5$ dB(A)		% of measurements $\leq L_B + 5$ dB(A)	

Table 10 : Measuring results: measurements in conditions other than the CSR - summary

No. of measurements $x\%$ MCR		%	
No. of measurements $L_{x\%MCR} - L_{Aeq} \leq 3$ dB or $L_{x\%MCR} \leq L_A + 5$ dB (A)		No. of measurements $L_{x\%MCR} \leq L_B + 5$ dB (A)	
No. of measurements MCR		%	
No. of measurements $L_{MCR} - L_{Aeq} \leq 3$ dB or $L_{MCR} \leq L_A + 5$ dB (A)		No. of measurements $L_{MCR} \leq L_B + 5$ dB (A)	

Table 11 : Measurements at berth (Acoustic insulation from airborne noise)

Type of wall:			
Delimited spaces:			
Position No.	R'_w measured	R'_w admitted	Deviation [dB]
1			
2			
...			

Table 12 : Measurements at berth (Acoustic insulation from impact sound)

Type of floor:			
Above space:			
Position No.	$L'_{n,W}$ measured	$L'_{n,W}$ admitted	Deviation [dB]
1			
2			
...			

SECTION 2

COMFORT WITH REGARD TO VIBRATIONS ON BOARD SHIPS

1 General

1.1 Application

1.1.1

COMF-VIB notation, in accordance with Pt A, Ch 1, Sec 2, [6.7.3] is assigned to ships classed by the Society and complying with the requirements of this Section.

In the event that the ship undergoes modifications, refitting or repairs that may affect its level of comfort, the maintenance of the notation is subject to the results of new measurements as deemed appropriate by the Society.

The notation is completed by a letter **A**, **B** or **C** which represents the merit level achieved for the assignment of the notation, the merit **A** corresponding to the lowest level of vibration. The notation **COMF-VIB** is only assigned if at least merit level **C** is reached.

When the merit levels achieved for the passenger spaces (if any) and the crew spaces are different, the notation is completed by the suffix:

- **PAX**, for passenger spaces, and
- **CREW**, for crew spaces.

1.1.2

Ships not classed by the Society complying with the requirements of this Section are provided with a Certificate of Conformity which attests their comfort quality. The Certificate is valid for a period of 5 years and may be extended, at the request of the Owner, for an additional 5-year period based on a limited set of measurements covering at least 5% of those made when the Certificate was first issued.

1.1.3

The requirements apply to conventional passenger and cargo ships irrespective of the ship's age, as far as reasonable and practicable, to the satisfaction of the Society.

For ships of less than 65 m (length between perpendiculars), special consideration will be given by the Society, in particular concerning the requirements in item [7].

1.2 Basic principles

1.2.1

These Rules define the limits of acceptability of vibration on board, the methods for verification of compliance and the criteria for acceptance. They are based, as appropriate, on international standards and are deemed to preserve the general principles of such standards.

1.2.2

Verification of compliance is based on the measurements of vibration levels in ship spaces. These measurements are to be carried out either by a Surveyor of the Society or by a

technician from a company recognised as qualified by the Society. In the latter case, measurements are to be performed under the surveillance of a Surveyor of the Society.

2 Definitions

2.1 Categories of spaces

2.1.1 General

For the purposes of this Section, a specific, comfort-related categorisation of the ship spaces is used.

2.1.2 Crew spaces

Crew spaces are those described in IMO Resolution A.468(XII).

2.1.3 Passengers spaces

With the exception of garages, washrooms and toilets, to which the requirements of this Section do not apply, passenger spaces are the following:

a) Standard cabins

Spaces for private use of the passengers, where the primary purpose is to rest.

b) Suites or mini-suites

Luxury finish cabins greater than 15m² with private lounge area with an extension at least 30% of the total surface.

c) Type A entertainment spaces

Enclosed spaces for passenger recreation and/or prolonged passenger stay where the noise level is normally high when in use (e.g. discos, theatres, cinemas, casinos, show rooms, etc.).

d) Type B public spaces

Enclosed spaces for passenger recreation and/or prolonged passenger stay where the noise level is not normally high when in use (e.g. self service restaurants, main restaurant, pullman seat rooms, lounge areas, bars, gymnasiums, conference halls and similar spaces, etc.).

e) Type C public spaces

Enclosed spaces for passenger recreation and/or prolonged passenger stay where the noise level is low (e.g. reading rooms, libraries, card rooms, chapels, special restaurants, health centre, sitting rooms, small lounges, and similar spaces, etc.).

f) Type D public spaces

Spaces where passengers are not normally expected to stay long (e.g. shops, enclosed walkways, atriums, passenger laundrettes, halls and similar spaces, etc.).

g) Type E transit spaces

Spaces where passengers are normally expected to stay for a short period of time (e.g. corridors, stairs, etc.).

h) Type F open spaces

Outside spaces for prolonged and/or recreational stay of passengers (e.g. swimming pool area, jacuzzi area, open walkways, sun decks, etc.).

2.1.4 Work Spaces

Service spaces (such as galleys, serveries, pantries, technical spaces, workshops, passageways, etc.) with significant random noise levels or potential high noise levels above 85dBA.

2.2 Vibration

2.2.1

Time variation of the value of a physical quantity described by either the motion or the position of a mechanical system when this value is alternatively greater or smaller than a mean reference value.

As far as these Rules are concerned, the physical quantity for reference is: in the frequency range from 1 to 5 Hz, the structural acceleration measure in mm/s^2 , and in the frequency range from 5 to 100 Hz, the structural velocity measure in mm/s .

2.3 Operational power in the CSR condition

2.3.1

Operational power is the propulsion power, in kW, at which the ship is normally operated.

2.3.2

The operational power to be considered for the purpose of these Rules is 85% of the maximum continuous rate (MCR) defined in the following as the continuous service rate (CSR) condition.

2.3.3

Subject to the acceptance of the Society and to the agreement of the Owner and shipyard, a propulsion power at CSR other than 85% MCR is to be used, if such condition corresponds to the normal seagoing conditions.

3 General Requirements

3.1 Design requirements

3.1.1 Vibration design prognosis

A vibration design prognosis is a forecast based on Finite Element Models (FEM) of the full ship (3D models), carried out early in the design stage, of the expected vibration velocities in the ship spaces.

Although a vibration design prognosis is not required to be submitted, it is recommended that it should be carried out by the Designer, in particular for passenger ships, in order to properly design the structural arrangements so as to prevent high vibration levels.

3.2 Constructional Requirements

3.2.1 Vibration measurement plan

A plan describing the proposed vibration measurement campaign, in compliance with [5.2], is to be developed. The plan is to include the extension and classification of ship zones and the proposed minimum number of measurements to be taken in each ship space. The aim is to obtain a rational distribution of measurement points throughout the ship.

3.2.2 Vibration measurement report

A duly signed detailed report is to be submitted. The forms shown in item [8] may be used for this purpose.

The report is to contain:

- position of measurement points
- measured vibration levels
- for each vibration measuring point, the spectrum of the structural velocity in the frequency range of investigation, as produced by the portable analyser, together with an indication of the frequency and value of the main peaks
- resulting comfort level

The following general data and conditions are to be recorded and included in the report:

- ship loading condition
- propulsion machinery, main auxiliaries, navigational aids, radio and radar sets
- water depth
- environmental conditions (wind and waves)

4 Documentation to be submitted

4.1 Measurement plan

4.1.1

The proposed detailed measurement plan, developed according to [3.2.1], is to be submitted for approval well in advance of the measurement campaign.

4.2 Vibration measurement results

4.2.1

A duly signed detailed report is to be submitted for approval. The format shown in item [8] is recommended.

The vibration measurement report is to be witnessed by a representative of the Builder, the Owner, a representative of the company which carried out the measurements and the Surveyor in charge of surveillance of the measurements.

5 Measurements of vibration levels

5.1 Testing conditions

5.1.1 General

Vibration levels are to be measured in the conditions defined below. Different conditions may be accepted as equivalent at the discretion of the Society.

As far as possible the ship is to proceed on a straight course.

5.1.2 Equipment running during the tests

During measurements, all auxiliary systems, forced ventilation and air conditioning systems (HVAC systems) and hotel service systems are to be operating in normal service conditions.

The rooms are to be fully equipped with furniture, furnishings, ceiling and actual deck covering (e.g. carpet).

5.1.3 Ship loading conditions

As far as practicable the ship loading conditions are to be as close as possible to the normal operating conditions.

5.1.4 Environmental conditions

Water depth is to be sufficiently great and at least 10 times the medium ship draught.

In general, meteorological conditions are to be within the following limits:

- wind: not stronger than Beaufort 3 - strong breeze (speed 7 to 10 knots),
- waves: not stronger than force 3 - rough (significant wave height 0,5 to 1,25 m).

5.1.5 Propulsive Power

- a) Measurements are to be carried out with the ship working at the operational power in the CSR condition in [2.3].
- b) Additional measurements are to be carried out at 100% MCR and at x% MCR, the different propulsion power with respect to CSR is subject to the acceptance of the Society and to the agreement of the Owner and shipyard.

5.1.6 Other equipment

Subject to the acceptance of the Society and to the agreement of the interested party, equipment such as bow thrusters, stabilising fins etc., is to be operating during measurements if it is necessary for the ship to proceed in normal seagoing conditions and in the environmental conditions specified in [5.1.4].

With the above-mentioned equipment operating, special consideration may be given by the Society concerning the acceptable vibration level as per [7].

5.2 Measurement positions

5.2.1 General

Measurements are to be carried out in the spaces defined in [2.1] according to the general principles of ISO 4867-1984 and ISO 4868-1984. At the discretion of the Society, additional measurements are to be carried out where evidence of local vibration occurs.

For reference purposes, the components of vibration at least in 2 points on the same deck as close as possible to the longitudinal position of the propeller(s), one on the centreline, one on the side, are to be measured. It is recommended that for these 2 points, a real-time record of vibration with the

time histories wave-form and the frequency spectra is provided.

5.2.2

In passenger spaces, at least 10 measurements points for each deck, with at least 3 measurements for the main vertical zone, are to be taken. 50 % of the measurement points are to be located in the zone between the ship's extreme aft and the forward bulkhead of the engine room.

For crew spaces at least 6 measurements for each deck are to be taken.

6 Instrumentation

6.1 General

6.1.1

Vibration levels (V_{mis}) are to be recorded by means of a portable analyser (vibrometer) in the frequency domain (spectrum). Instrumentation is to comply with the requirements of ISO 8041. This compliance is to be verified at least every two years by an organization recognised by the Society.

The date of last verification and confirmation of compliance with relevant standards is to be recorded. Calibration sheets are to be provided.

Where applicable, the fast fourier transform (FFT) analyser settings to obtain the vibration spectrum are to be the following:

- frequency range 1 - 100 HZ
- time window type hanning with overlap equal to 2/3 or 3/4 (66,7% or 75%)
- number of spectral line at least 400
- linear or exponential averaged spectra.

Different instrumentation settings will be considered by the Society on a case-by-case basis.

6.2 Measurement procedure

6.2.1

Vibration level measurements are to be carried out by recording the 0 - peak value of harmonic components of structural acceleration, in mm/s² in the frequency range from 1 to 5 Hz and the structural velocity, in mm/s, in the frequency range from 5 to 100 Hz, by means of a portable analyser connected to an accelerometer.

Alternatively, Root Mean Square (RMS) values may be recorded instead of the 0 - peak values. It is noted that RMS values correspond to the 0 - peak value divided by $2^{1/2}$.

The vibration levels of the spectra line are to be averaged over a length of time of at least 30 s. If significant evidence of modulation appears in the vibration levels, the spectrum will be averaged over a length of time of 60 s.

In the comfort level assessment, for each measurement position only the maximum vibration among the vertical, transversal or longitudinal components will be considered.

7 Acceptance Criteria

7.1 Vibration levels in the CSR condition

7.1.1

For each type of space, limit values (V_{lim}) depending on the vibration comfort level are given in Tab 1, as well as in Fig 1, which also shows the numerical limits (constant acceleration curve) for frequencies below 5 Hz.

Values of vibration levels above V_{lim} may be neglected provided that:

- they do not concern more than 10 % of the total area of deck within the main vertical zone

and they are below:

- $V_{lim} + 1,5 \text{ mm/s}$ for for frequency f : $5 \leq f \leq 100 \text{ Hz}$.
- $a_{mis} \leq a_{lim} + 47,1 \text{ mm/s}^2$ for frequency f : $1 \leq f \leq 5 \text{ Hz}$.

7.2 Vibration levels at different condition than CSR

7.2.1

The aim of these measurements is to verify that on each deck the vibration levels are not excessive. The measurements are to involve critical areas up to 10 % of the total number of measurements for each deck, taken at the operational power.

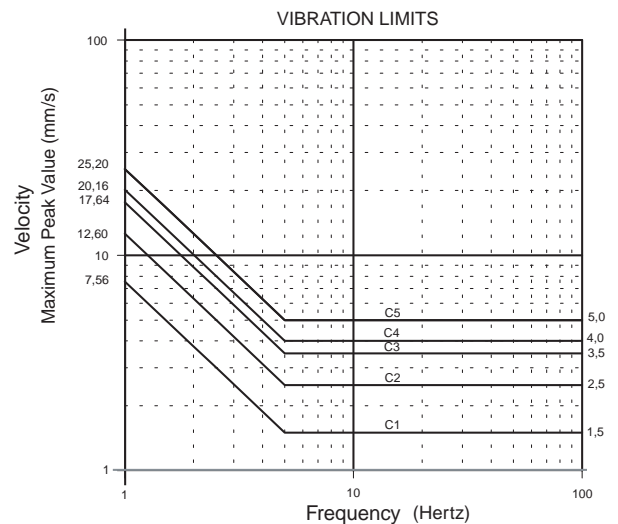
Critical areas are those where highest vibration levels have been measured.

For each critical area the measured values are to be compared with the following vibration limits.

Comfort level is assigned if at least:

- $V_{mis} \leq V_{lim} + 2,0 \text{ mm/s}$ for frequency f : $5 \leq f \leq 100 \text{ Hz}$.
- $a_{mis} \leq a_{lim} + 62,8 \text{ mm/s}^2$ for frequency f : $1 \leq f \leq 5 \text{ Hz}$.

Figure 1 : All ships



7.3 Comfort Levels

7.3.1

The comfort level is rated on the basis of the actual rating reached by vibration level, provided that at least C level is reached.

The global vibration comfort level is assigned as follows:

- Comfort level is A if:
 - at CSR all $V_{mis} \leq V_A$, and
 - the criteria in [7.2.1] in a condition other than the CSR are satisfied
- Comfort level is B:
 - at CSR all $V_{mis} \leq V_A$,
 or
 - at CSR all $V_{mis} \leq V_B$, and the criteria in [7.2.1] in a condition other than the CSR are satisfied
- Comfort level is C if at CSR all:
 - $V_{mis} \leq V_B + 1,5 \text{ mm/s}$ for frequency f : $5 \leq f \leq 100 \text{ Hz}$.
 - $a_{mis} \leq a_B + 47,1 \text{ mm/s}^2$ for frequency f : $1 \leq f \leq 5 \text{ Hz}$.

Table 1 : CSR condition - Vibration limit levels

Type of Spaces	V_A		V_B	
	1 < f < 5 Hz Acceleration 0-peak mm/s ² (RMS values = Peak / 2 ^{1/2})	5 ≤ f ≤ 100 Hz Vibration 0-peak mm/s (RMS values = Peak / 2 ^{1/2})	1 < f < 5 Hz Acceleration 0-peak mm/s ² (RMS values = Peak / 2 ^{1/2})	5 ≤ f ≤ 100 Hz Vibration 0-peak mm/s (RMS values = Peak / 2 ^{1/2})
Passenger spaces				
Suites or mini-suites	31,4	1,0	78,5	2,5
Standard cabins	47,1	1,5	94,3	3,0
Type A, B, and D spaces	62,8	2,0	125,7	4,0
Type C spaces	47,1	1,5	94,3	3,0
Type E spaces	62,8	2,0	157,1	5,0
Type F spaces	94,3	3,0	157,1	5,0
Crew spaces				
Crew cabins	62,8	2,0	110,0	3,5
Senior crew cabins	47,1	1,5	94,3	3,0
Navigation spaces	78,5	2,5	125,7	4,0
Radio Room	78,5	2,5	125,7	4,0
Hospital	47,1	1,5	94,3	3,0
Public crew spaces	78,5	2,5	157,1	5,0
Service spaces	78,5	2,5	157,1	5,0
Work spaces	78,5	2,5	125,7	4,0
Offices	78,5	2,5	125,7	4,0
Mess Room	78,5	2,5	125,7	4,0
ECR	78,5	2,5	125,7	4,0
Crew open deck	94,3	3,0	157,1	5,0

8 Report

8.1

8.1.1

The report for vibration measurements is to contain the following tables.

Table 2 : Characteristics of the ship

Name of the ship			
Register number RI			
Flag			
Name of the Owner			
Name of the shipyard			
Construction number			
Type of ship			
Dimensions			
Length - L		m	
Breadth - B		m	
Depth - D		m	
Max. draught - T		m	
Displacement at draught T	t		
Velocity at MCR	knots		
Propulsion Power MCR	kW		
Propulsion Power CSR	KW		%MCR

Table 3 : Characteristics of the machinery

Propulsion machinery			
Manufacturer			
Type			
Number of units			
Max. continuous power		kW	
Shaft speed		rev./min	
Type of propeller			
Number of propellers			
Number of blades			
Shaft speed at MCR		rev/min	
Propeller Diameter		m	
Propeller Pitch at MCR			
Controllable Pitch			
YES		NO	
Stabilising fins, bow thruster etc. needed for normal operation:			
YES		NO	

Table 4 : Measuring instrumentation - vibration

Instrumentation / Manufacturer	
Type	

Table 5 : Conditions during measurement

Date			
Starting time			
Finishing time			
Position of the craft			
Type of voyage			
Conditions during measurement			
Draught forward	m		
Draught aft	m		
Depth of water under keel	m		
Weather conditions			
Wind force / speed	Bf -m/s		
Sea state / average wave height	SS -m		
	CSR	MCR	x%MCR
Speed of the ship	knots		
Propeller shaft speed	rev/min		
Propeller pitch setting			
Propulsion machinery speed	rev/min		
Propulsion machinery power	kW		
Percentage of the Maximum Continuous Rate	%	100	
No. of propulsion machinery units operating			
No. of generators operating			
No. of units of auxiliary machinery operating			

Table 6 : Measuring results: measurements at operational power - details

Position No.	Type of space: Cb: Std. Cabin; S: Suite or mini-suite; A, B, C, D, E, F; Crew Cb: Crew Std. Cabin; Crew S: Senior officer cabins ; Crew office, Crew workspace, Crew navigation, Crew public	Freq. V_{mis} [hz]	V_{mis} 0 - peak [mm/s] CSR	V_{mis} 0 - peak mm/s MCR	V_{mis} 0 - peak mm/s x%MCR
1					
2					
...					

Table 7 : Measuring results: measurements in the CSR condition - summary

Total number of measurements			
No. of measurements $\leq V_A$		% of measurements $\leq V_A$	
No. of measurements $\leq V_B$		% of measurements $\leq V_B$	
No. of measurements $\leq V_B + 1$ mm/s		% of measurements $\leq V_B + 1,0$ mm/s	

Table 8 : Measuring results: measurements in conditions other than the CSR - summary

No. of measurements x% MCR		%	
No. of measurements x% $MCR \leq V_A + 2 \text{ mm/s}$		$\% \leq V_A + 2 \text{ mm/s}$	
No. of measurements x% $MCR \leq V_B + 2 \text{ mm/s}$		$\% \leq V_B + 2 \text{ mm/s}$	
No. of measurements MCR		%	
No. of measurements $MCR \leq V_A + 2 \text{ mm/s}$		$\% \leq V_A + 2 \text{ mm/s}$	
No. of measurements $MCR \leq V_B + 2 \text{ mm/s}$		$\% \leq V_B + 2 \text{ mm/s}$	

SECTION 3

COMFORT WITH REGARD TO CLIMATE ON BOARD SHIPS

1 General

1.1 Application

1.1.1 Premise

The feeling of comfort with regard to climate is subjective and depends on many different factors, such as environmental factors (air temperature, temperature gradient, thermal radiation, light, air speed, humidity, etc.) and personal factors (metabolism, state of person's health, clothing, activity, etc.). This makes it almost impossible to determine a standard which may establish satisfactory conditions for all people.

However, there are certain ranges of temperatures, humidity, air speed, etc. that may give a feeling of comfort to the majority of healthy people, wearing standard type of clothes and performing normal activity in a certain space, the number of unsatisfied people being limited to a small percentage of the total occupants of such a space.

The purpose of these Rules is to establish a number of climatic parameters that can satisfy the majority of crew and passengers on a ship and the way to ascertain that the HVAC system of the ship is adequate to provide such arrangements in all the design conditions.

1.1.2 Application

- a) The notation **COMF-AIR**, in accordance with Pt A, Ch 1, Sec 2, [6.7.4], will be granted to ships complying with the requirements of this section.
- b) The notation **COMF-AIR** may have one of the suffixes **W** and/or **S** meaning that the HVAC system has been satisfactorily tested in Winter and/or Summer conditions, respectively, as stated in [1.5.1].
- c) These Rules apply to spaces in which there are normally crew members and passengers (accommodation spaces for crew and passengers, wheelhouses, control rooms, offices).
- d) The Rules are not applicable to service spaces, such as laundries, galleys, workshops, stores, service stairs and garages, which are to comply with the existing applicable national standards (if any).

1.1.3 Ship categories

Ships are divided into two main categories, taking into consideration the specifics of the ship in the air control field, and the technical feasibility for the ship to comply with these Rules at a reasonable cost:

- a) Passengers ships, including cruise ships, ferries and liners, in which comfort needs particular care.
- b) Heavy duty ships, namely all types of cargo ships, including tankers, container ships, bulk carriers, etc.

where minimum comfort is necessary to prevent human errors due to excessive stress of the crew, caused by an unsatisfactory climatic condition in those spaces where activities essential for the safety of the ship are performed.

1.2 Definitions

1.2.1 HVAC

HVAC is a combined heating-ventilation-air conditioning system.

1.2.2 Crew accommodation

Crew accommodation includes cabins, offices, hospitals, mess rooms, recreation rooms and open deck areas to be used by the ship's officers and crew.

1.2.3 Passenger accommodation

Passenger accommodation includes all areas intended to be used by the passengers.

1.2.4 Public spaces

- a) Public spaces are all those spaces allocated to passengers, including public spaces for prolonged and/or recreational stay, as well as spaces for non prolonged passenger stay.
- b) Service stairs and garages are not considered as part of this definition.
- c) As far as these Rules are concerned, the following definitions of enclosed public spaces are used:
 - 1) Type A spaces:
Enclosed spaces for either passenger recreation and/or prolonged passenger stay intended for intensive physical activity (discos, gymnasiums, etc.)
 - 2) Type B spaces:
Enclosed spaces for either passenger recreation and/or prolonged passenger stay intended for medium physical activity or which are normally crowded (restaurants, bars, cinemas, gaming rooms, conference halls, theatres, casinos, lounges, etc.)
 - 3) Type C spaces:
Enclosed spaces for either passenger recreation and/or prolonged passenger stay intended for light physical activity (reading rooms, libraries, card rooms, chapels, etc.)
 - 4) Type D spaces
Spaces where passengers are not normally expected to stay long (shops, enclosed walkways, halls, corridors, etc.).

1.2.5 Passenger cabins, suites and mini-suites

Passenger cabins, suites and mini-suites are spaces for private use of passengers.

1.2.6 Climate

Climate is the set of physical factors that affect the feeling of comfort or discomfort of persons in a certain environment.

1.2.7 Ambient temperature (internal)

The ambient temperature is the average temperature resulting from a number of different temperature measurements taken in a certain time in a specific space.

1.2.8 Temperature gradient

For the purpose of these Rules, the temperature gradient is the vertical difference in temperature in a certain location between a point located at a distance of 0,1 m from the floor and a point located at a distance of 1,7 m from the floor.

1.2.9 Outside air temperature

The outside air temperature is the temperature measured outside the space considered in a position which is not exposed to the sun.

1.2.10 Dry bulb temperature

The dry bulb temperature is the temperature indicated by a dry temperature-sensing element shielded from the effects of radiation.

1.2.11 Wet bulb temperature

The wet bulb temperature is the temperature measured by a thermometer whose bulb is covered by a wetted wick and exposed to a current of rapidly moving air.

1.2.12 Relative humidity

Relative humidity is the ratio between the mass of vapour present in a volume of air and the mass of vapour required to saturate the same volume of air.

1.2.13 Air velocity

Air velocity is the mean velocity of a mass of air.

1.2.14 Draught

Draught is the local cooling of the body due to air movement. In general this is an unpleasant feeling.

1.2.15 Thermo-refrigerating station

The thermo-refrigerating station includes the refrigerating units and the thermal units.

- a) The refrigerating unit includes one or more refrigerant compressors with associated condensers and evaporators, with the relevant control and regulation apparatus, as well as the sea water pumping system for cooling the condenser.

The refrigeration of the air may be obtained by one of the following methods:

- by expansion of the refrigerant;
 - by heat exchange with a flow of cooled air. In such case the refrigerating unit includes the pumping system necessary for the circulation of the secondary refrigerants.
- b) The thermal unit includes one or more heat exchangers for the production of the hot water necessary to heat the air, the control and regulation apparatus, as well as the pumping system for the circulation of the hot water.

1.2.16 Air treatment unit

The air treatment unit is an adequately fitted and insulated metallic box containing all the equipment (fans, cold and hot heat exchangers, humidifying filters, condensate water collecting pans, etc.) necessary to treat the external air and to prepare the mixture of air to be sent to the various spaces.

1.3 Basic principles

1.3.1 Compliance with the Rules

Compliance with these Rules is verified by means of plan review and measurements to be carried out on board in the conditions and locations indicated in this Section.

1.3.2 Measurements

The measurements, required by this Section, are to be taken either by a Surveyor from the Society or by a technician from a company recognised as suitable by the Society. In the latter case, measurements are to be carried out under the surveillance of a Surveyor.

1.3.3 International standards

These Rules are based on the most recent international standards and requirements relevant to climatic conditions. Tab 1 lists some of these standards. The list is given for information; where some of the listed standards have more severe requirements than those indicated in this Section, compliance with the following requirements is considered sufficient for the issuance of the **COMF-AIR** notation, unless otherwise indicated.

1.4 Documentation to be submitted

1.4.1 Description of HVAC system

A description of the HVAC system is to be submitted to the Society. Such description is to include the technical specification of the system and the design criteria.

The subsequent analysis will be used as the basis for the assessment of the results of the measurements on board (see [1.5.1] and [3.2.4]).

Table 1 : International standards

Standard	Number	Title
ISO	7726	Thermal environments - Instruments and methods for measuring physical quantities
ISO	7730	Moderate thermal environments - Determination of PMV and PPD indices
ISO	7547	Air conditioning and ventilation of accommodation spaces on board ships - Design considerations and basis of calculations
ISO	8862	Air conditioning and ventilation of machinery control rooms on board ships - Design conditions and basis for calculations
ISO	8864	Air conditioning and ventilation of wheelhouse on board ships - Design conditions and basis for calculations
ANSI /ASHRAE	55-1992	Thermal environmental conditions for human occupancy
ANSI /ASHRAE	62-1989	Ventilation for acceptable indoor air quality
ANSI /ASHRAE	1995 Handbook	HVAC applications
ANSI /ASHRAE	1997 Handbook	Fundamentals
WHO (1)	EURO reports and studies 78, 83	Indoor air pollutants -Exposure and health effects
WHO (1)	Series 23,1987	Air quality guidelines for Europe
(1) World Health Organization		

1.4.2 Measurement plan

- a) In order to obtain the notation, measurements of temperature, air velocity and humidity are to be taken as indicated in [3.1] and [3.2].
- b) A detailed measurement plan is to be submitted, in order to assess compliance with these Rules.
- c) The plan is to include:
 - extension and classification of ship zones
 - position of ventilation and HVAC system inlets and outlets
 - type and minimum number of measurements to be taken in each ship space concerned
 - proposed locations of measurement points
 - expected environmental conditions during the measurements.

1.5 Measurements on board

1.5.1 Measurement conditions

- a) Due to the impossibility of performing enough representative measurements to demonstrate the functioning of the HVAC in the full range of design climatic environmental conditions, at least two sets of measurements are to be performed to represent the Winter and Summer conditions respectively, as follows:

1) Winter conditions

- Difference of temperature between actual outside air temperature and design indoor temperature not less than 50% of the difference between

the design outside air temperature and the design indoor temperature.

- Weather conditions may be cloudy to partly cloudy sky.

2) Summer conditions

- Difference of temperature between actual outside air temperature and design indoor temperature not less than 50% of the difference between the design outside air temperature and the design indoor temperature.
- Difference of humidity between actual outside air humidity and indoor humidity not less than 50% of the difference between the design outside air humidity and the design indoor humidity.
- Weather conditions are to be clear to partly cloudy sky.

- b) Subject to satisfactory completion of one of the two sets of measurements, the **COMF-AIR** notation followed by the appropriate suffix **W** or **S**, depending on the actual testing conditions, will be granted to the ship. Subject to satisfactory completion of the second set of measurements, if requested by the Owner, the full **COMF-AIR** notation (without any limitation) will be granted. In general this second set of measurements is to be performed within one year from the completion of the first set.

- c) The results of these two sets of measurements will be compared with the documents mentioned in [1.4.1] and [3.2.4]. Where these results are not found to be in

substantial agreement, additional measurement sets may be requested by the Society.

- d) In the case of ships mainly intended for particular trades, alternative requirements may be considered by the Society on a case -by-case basis.

1.5.2 Reporting of results

- a) Upon completion of a measurement set, as per [1.4.2] [1.5.1] and [3.2], a detailed report is to be submitted. The forms shown in [5] may be used for this purpose.
- b) The report is to contain:
- position of measurement points
 - measured levels
- c) The following general data and conditions are to be recorded and included in the report:
- ship loading condition
 - propulsion machinery, main auxiliaries, navigational aids, radio and radar sets
 - water depth
 - environmental conditions.

2 Basic design requirements

2.1 Design criteria

2.1.1 General

Alternative design conditions may be used, provided acceptable technical justification are forwarded to the Society.

2.1.2 Air design temperature

- a) The design outside air temperature is to be taken as follows:
- WINTER
not over - 5 °C,
 - SUMMER
not less than + 32 °C.
- b) The design inside air temperatures are given in [3.2].

2.1.3 Sea water design temperature

The design sea water temperature is to be taken as follows:

- WINTER
not more than - 2 °C,
- SUMMER
not less than 30 °C.

2.1.4 Humidity

- a) The design outside relative humidity in Summer is to be taken not less than 70%.
- b) The design inside relative humidity in Winter and in Summer is to be in accordance with [3.2.5], however in any case it is to be not less than 30% and not more than 60%.

2.2 Design details

2.2.1 Temperature control

- a) An adequate system for the control and the regulation of the temperature is to be provided.
- b) For passenger ships all the above regulators fitted in the suites, mini-suites and passenger cabins are to be arranged with a device for automatic regulation of the temperature.

2.2.2 Temperature gradient

The temperature gradient, as defined in [1.2.8], is not to exceed 3 °C.

2.2.3 Temperature difference

In general the difference in temperature between two different locations at the same level (height from the floor) of a space is not to exceed 2 °C.

2.2.4 Floor temperature

The surface temperature of the floors is to be not less than 19°C and not greater than 26°C. Where a floor heating system is used, different values may be agreed with the Society.

2.2.5 Service continuity

- a) A reduction of the plant capability due to a failure of equipment is acceptable for the refrigerating part of the system.
- b) In the case of any failure of the plant, it is to be capable of continuing to work in those spaces which are not affected by the failure.

2.2.6 Machinery and equipment

The various system components such as prime movers, compressors, pressure vessels, heat exchangers, ducts, filters, etc. are to be designed, built and tested in accordance with the applicable parts of the Rules.

2.3 Ventilation

2.3.1 Calculation of air supply

The supply of air to each space is to be calculated in accordance with the Standard "ISO 7547", considering the gross volume of the space considered without any deduction for furniture and other stationary equipment.

2.3.2 Air recirculation

The air supply may partly consist of recirculated air. However, the supplied air to each space is to have an airflow of outdoor air not less than 0,008 m³/s for each person for which the space is designed, or equal to at least 40% of the total supplied air, whichever is the greater.

2.3.3 Air temperature

The temperature at the inlet of the air supplied to a space is to be:

- not less than 10 °C lower than the average temperature in the space, when in the cooling mode;
- not more than 23 °C higher than the average temperature in the space, when in the heating mode.

2.3.4 Air velocity

For air velocity design requirements see [3.2.10].

2.3.5 Air quality

- a) Ventilation ducts are to be constructed and maintained in such a way as to minimise the opportunities for the growth and dissemination of micro-organism through the ventilation system.
- b) Airborne particulate contaminants, such as microorganisms, dust, fumes, smoke, and other dangerous substances are to be captured by adequate filters and/or dust collectors.

2.3.6 Filters

- a) Filters are to be of a type that is easy to clean or replace and only requiring the shut off for a limited time of the ventilation of one sector of the ship.
- b) Tab 2 indicates the minimum required filtering capacity for certain spaces of the ships.

Table 2 : Filtering capacity

Space	Minimum dimensions of 90% of particles trapped by new filters in micron	
	Passenger ships	Heavy cargo ships
Suites or mini-suites	1	-
Standard passenger cabins	4	-
Type A recreational space	4	-
Type B recreational space	4	-
Type C recreational space	1	-
Type D recreational space	9	-
Wheelhouse	4	4
Radio room	4	4
Crew cabins	9	9
Offices	4	9
Mess rooms	9	9
Hospitals	1	4
Engine control rooms	9	9

2.3.7 Alternative ventilation system

An alternative natural or forced ventilation system is to be provided for wheelhouses, control rooms and hospitals, in case of a major failure of the main HVAC system.

2.4 Calculations of heat gains and losses

2.4.1 The calculations of heat gains and losses are to be carried out by means of a Standard acceptable to the Society, using parameters obtained from standards, experience, direct measurement and data banks.

2.5 Maintenance

2.5.1 The HVAC is to be designed and arranged in such a way as to enable inspections, cleaning and ordinary main-

tenance without stopping the entire system, and shutting off only one section of the plant at a time for a limited period.

2.6 Inspection and tests during manufacturing

2.6.1 Prime movers, compressors, pressure vessels, heat exchangers, ducts, etc. are to be tested at the Manufacturer's premises in accordance with the applicable parts of the Rules.

2.7 Inspection and testing after completion

2.7.1 Hydrostatic tests

After installation on board and prior to starting operation, the plant is to be subjected to a test at its maximum working pressure.

However, all pressure piping portions which have welded joints made on board are to be subjected to a strength test at a pressure equal to 1,5 times the rated working pressure before being insulated.

2.7.2 Tests of the ventilation system

- a) After installation, the ventilation system is to be tested and the pressure, air capacity in cubic metres per minute, maximum rotational speed and power absorbed by the fans are to be recorded.
- b) The distribution of air in the various spaces is to be checked.
- c) The setting systems of the various plants are to be tested.

2.7.3 Water system tests

The hot and cold water system is to be subjected to working tests.

2.7.4 Operational tests

For the operational tests on board see [1.5] and [3.2].

3 Experimental test criteria

3.1 General

3.1.1 Different conditions may be considered, if accepted, as equivalent for the purposes of these Rules at the discretion of the Society.

3.2 Comfort level

3.2.1 Parameters to be measured

- a) In each of the spaces indicated in Tab 3 the following parameters are to be measured and recorded:
 - Ambient temperature (internal)
 - Average air velocity
 - Average relative humidity.
- b) Additional measurements of temperature gradient and floor temperature in certain representative locations will be agreed on a case-by-case basis with the Society.

3.2.2 Measurement positions

- Measurements are to be taken in all the public and working spaces as well as in at least one cabin for each type and for each plant sector; however not more than 30% of the cabins, suites and mini-suites need to be tested.
- The cabins selected for the measurements are to be evenly distributed in the various decks and fire zones of the ship.
- For small passenger ships and heavy cargo ships, at least three cabins are to be measured for each deck and/or each fire zone.
- The minimum number of measuring points is to be as follows:
 - Cabins having a floor surface equal to or less than 25 m², 1 measurement point.
 - Suites, mini-suites and hospitals having a floor surface greater than 25 m², 1 measurement point for every additional 25 m² (or fraction) of floor surface.
 - Other spaces having a floor surface equal to or less than 60 m², 1 measurement point.

- Other spaces having a floor surface greater than 60 m², 1 measurement point for the first 60 m² plus 1 measurement point for every additional 80 m² (or fraction) of floor surface.
- The temperature measurements are to be taken either in the middle of the space concerned (when only one measurement point is foreseen) or in positions which can be considered representative of the whole space (when more than one measurement point is foreseen). However, the distance of the measurement points from the walls and/or the HVAC system inlets and outlets is not to be less than 0,5 m. The distance of the measurement points from the floor is to be between 1,0 m and 1,7 m.

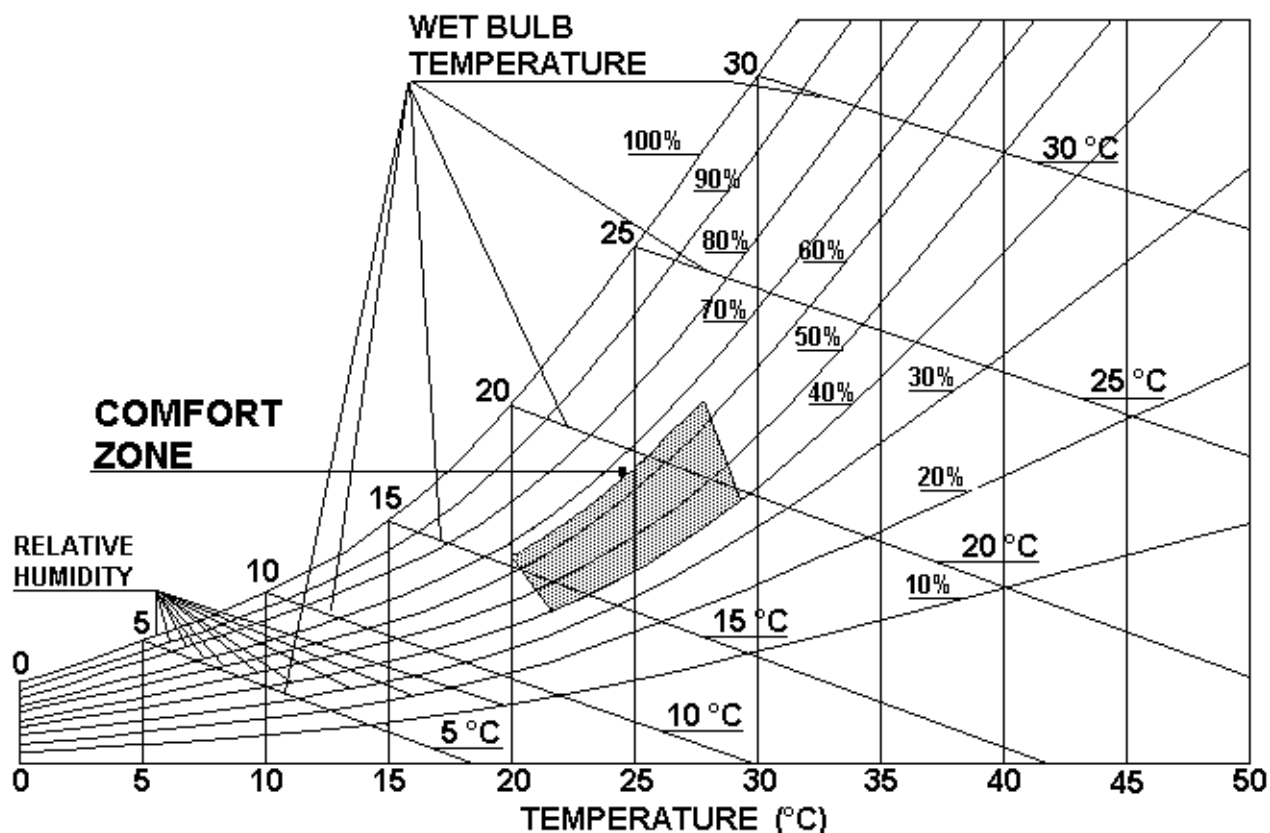
3.2.3 Temperature ranges

Tab 3 indicates the nominal ranges of the reference temperature T_o in Winter and in Summer conditions in the various spaces of the ship. The values actually obtained during the measurement are to be within the limits indicated in Tab 3, as modified in [3.2.6] [3.2.7], [3.2.8], [3.2.9].

Table 3 : Reference internal temperature ranges

Space	Winter conditions				Summer condition			
	Passenger ships		Heavy cargo ships		Passenger ships		Heavy cargo ships	
	Max T_o (°C)	Min T_o (°C)	Max T_o (°C)	Min T_o (°C)	Max T_o (°C)	Min T_o (°C)	Max T_o (°C)	Min T_o (°C)
Suites or mini-suites	23	22	-	-	25	22	-	-
Standard passenger cabins	23	22	-	-	26	22	-	-
Type A space	23	20	-	-	26	22	-	-
Type B space	23	21	-	-	26	22	-	-
Type C space	23	22	-	-	26	22	-	-
Type D space	23	21	-	-	26	22	-	-
Wheelhouse	23	22	23	22	25	22	25	22
Safety stations	23	22	23	22	25	22	25	22
Crew cabins	23	20	23	21	26	22	26	22
Offices	23	22	23	21	25	22	25	22
Mess rooms	23	21	23	21	26	22	26	22
Hospitals	23	22	23	22	25	22	25	22
Engine control rooms	23	22	23	22	25	22	25	22

Figure 1 : Psychrometric chart



3.2.4 Evaluation and correction of measured data

Where the measurements are carried out with an outside air temperature different from the design temperature, the measured values are to be checked against the lines of a compensation chart prepared by the shipyard and accepted by the Society.

3.2.5 Relative humidity

For all the spaces indicated in Tab 3 the measured relative humidity is to be contained in the shadowed area of the psychrometric chart in Fig 1.

3.2.6 Temperature comfort limits for passenger ships in Winter conditions

For each measured temperature, the T_{meas} values are to be compared with Tab 3.

- a) Suites or mini-suites, type C spaces, hospitals
Comfort level is considered satisfactory if:
all T_{meas} values are between $T_{max} - 1\text{ °C}$ and $T_{max} + 1,5\text{ °C}$, except for less than 20% of measured values, which are to be not less than $T_{min} - 0,5\text{ °C}$.
- b) Passenger cabins, type A, B and D spaces, wheelhouses, safety stations, control rooms
Comfort level is considered satisfactory if:
all T_{meas} values are between $T_{max} - 1,5\text{ °C}$ and $T_{max} + 1,5\text{ °C}$, except for less than 20% of measured values, which are to be not less than $T_{min} - 1\text{ °C}$.

- c) All other spaces

Comfort level is considered satisfactory if:

all T_{meas} values are between $T_{max} - 2\text{ °C}$ and $T_{max} + 1,5\text{ °C}$, except for less than 30% of measured values, which are to be not less than $T_{min} - 1,5\text{ °C}$

- d) Fig 2 gives a graphic representation of the temperature comfort limits for passenger ships in Winter conditions.

3.2.7 Temperature comfort limits for heavy cargo ships in Winter conditions

For each measured temperature, the T_{meas} values are to be compared with Tab 3.

- a) Wheelhouses, radio rooms, safety stations and hospitals
Comfort level is considered satisfactory if:
all T_{meas} values are between $T_{min} - 0,5\text{ °C}$ and $T_{max} + 1,5\text{ °C}$, except for less than 30% of measured values, which are to be not less than $T_{min} - 1\text{ °C}$.
- b) All other spaces
Comfort level is considered satisfactory if:
all T_{meas} values are between $T_{min} - 0,5\text{ °C}$ and $T_{max} + 1,5\text{ °C}$, except for less than 30% of measured values, which are to be not less than $T_{min} - 2\text{ °C}$.
- c) Fig 2 gives a graphic representation of the temperature comfort limits for heavy cargo ships in Winter conditions.

Figure 2 : Temperature comfort limits in Winter conditions (passenger and heavy cargo ships)

SPACE	TYPE OF SHIP	SPACE %	OPERATIVE TEMPERATURE																							
			18	18,5	19	19,5	20	20,5	21	21,5	22	22,5	23	23,5	24	24,5	25	25,5	26	26,5	27	27,5	28			
Suites and minisuites	PASSENGER	80																								
		20																								
Passenger cabins	PASSENGER	80																								
		20																								
Type A recreational spaces	PASSENGER	80																								
		20																								
Type B recreational spaces	PASSENGER	80																								
		20																								
Type C recreational spaces	PASSENGER	80																								
		20																								
Type D recreational spaces	PASSENGER	80																								
		20																								
Wheelhouse	PASSENGER	80																								
		20																								
		70																								
Safety stations	PASSENGER	80																								
		20																								
		70																								
Crew cabins	PASSENGER	80																								
		20																								
		70																								
Offices	PASSENGER	80																								
		20																								
		70																								
Mess rooms	PASSENGER	80																								
		20																								
		70																								
Hospitals	PASSENGER	80																								
		20																								
		70																								
Engine control rooms	PASSENGER	80																								
		20																								
		70																								

3.2.8 Temperature comfort limits for passenger ships in Summer conditions

For each measured temperature, the T_{meas} values are to be compared with Tab 3.

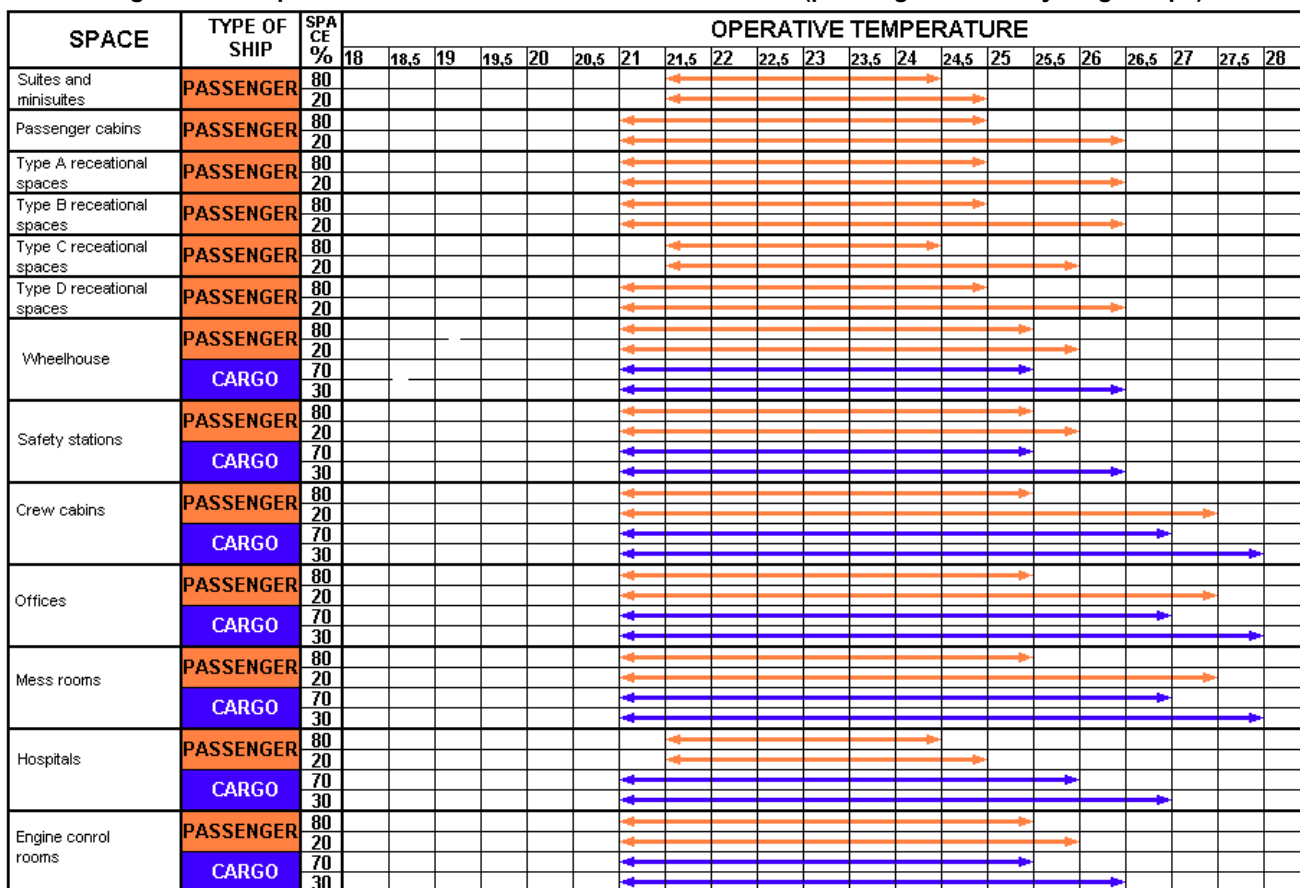
- a) Suites or mini-suites, type C spaces, hospitals
Comfort level is considered satisfactory if:
all T_{meas} values are between T_{min} - 0,5 °C and T_{min} + 2,5 °C, except for less than 20% of measured values, which are to be not greater than T_{max} + 0,5 °C
- b) Passenger cabins, type A, B and D spaces, wheelhouses, safety stations, control rooms
Comfort level is considered satisfactory if:
all T_{meas} values are between T_{min} - 1 °C and T_{min} + 3 °C, except for less than 20% of measured values, which are to be not greater than T_{max} + 1 °C.
- c) All other spaces
Comfort level is considered satisfactory if:
all T_{meas} values are between T_{min} - 1,5 °C and T_{min} + 3,5 °C, except for less than 20% of measured values, which are to be not greater than T_{max} + 1,5 °C.
- d) Fig 3 gives a graphic representation of the temperature comfort limits for passenger ships in Summer conditions.

3.2.9 Temperature comfort limits for heavy cargo ships in Summer conditions

For each measured temperature, the T_{meas} values are to be compared with Tab 3.

- a) Wheelhouses, safety stations, control rooms and hospitals
Comfort level is considered satisfactory if:
all T_{meas} values are between T_{min} - 1 °C and T_{max} + 0,5 °C, except for less than 30% of measured values, which are to be not greater than T_{max} + 1,5 °C.
- b) All other spaces
Comfort level is considered satisfactory if:
all T_{meas} values are between T_{min} -1,5 °C and T_{max} + 1 °C, except for less than 30% of measured values, which are to be not greater than T_{max} + 2 °C.
- c) Fig 3 gives a graphic representation of the temperature comfort limits for heavy cargo ships in Summer conditions.

Figure 3 : Temperature comfort limits in Summer conditions (passenger and heavy cargo ships)



3.2.10 Air velocity ranges

Tab 4 indicates the ranges of the air velocity in Winter and Summer conditions.

Table 4 : Air velocity ranges

Space	Passenger ships		Heavy cargo ships	
	Max air velocity (m/s)	Min air velocity (m/s)	Max air velocity (m/s)	Min air velocity (m/s)
Suites or mini-suites	0,25	0,15	-	-
Standard passenger cabins	0,35	0,25	-	-
Type A recreational space	0,40	0,25	-	-
Type B recreational space	0,40	0,25	-	-
Type C recreational space	0,35	0,20	-	-
Type D recreational space	0,40	0,25	-	-
Wheelhouse	0,30	0,20	0,30	0,20
Safety station	0,30	0,20	0,30	0,20
Crew cabins	0,40	0,25	0,45	0,30
Offices	0,35	0,25	0,45	0,30
Mess rooms	0,40	0,25	0,45	0,30
Hospitals	0,25	0,15	0,25	0,15
Engine control rooms	0,30	0,20	0,30	0,20

3.3 Notation for passenger ships

3.3.1 For passenger ships the notations may be granted even though the comfort level of the spaces not commonly used by the passenger does not reach the values established for such spaces, provided they can at least reach the values established for the same spaces in heavy cargo ships.

4 Testing procedures

4.1 Instrumentation

4.1.1 Thermometers

Temperature and humidity are to be measured by wet-and-dry bulb thermometers or by other approved methods.

4.1.2 Calibration

Measuring instruments are to be properly calibrated according to a recognised standard.

5 Appendix 1 - Forms

5.1 Characteristics of the ship

5.1.1 Tab 5 indicates the suggested format for recording data relative to the ship.

5.2 Characteristics of machinery

5.2.1 Tab 6 indicates the suggested format for recording data relative to the ship machinery.

Table 5 : Characteristics of the ship

Characteristics of ship	
Name of the ship	
Register number - RI	
Flag	
Port of registry	
Name of the shipowner	
Name of the shipyard	
Place of building	
Construction number	
Type of ship	
Dimensions	Length - L_{pp} (m)
	Breadth - B (m)
	Depth - D (m)
	Max. draught - T (m)
Displacement at draught T	
Date of delivery	

Table 6 : Characteristics of machinery

Characteristics of machinery	
Propulsion machinery	Manufacturer
	Type
	Number of units
	Max continuous power (kW)
	Shaft speed (rev/min)
Main reduction gear	Manufacturer
	Type
	Reduction ratio
Type of propeller	Type of propellers
	Number of propellers
	Number of blades
	Shaft speed at max. continuous power (rev/min)
Main auxiliaries	Manufacturer
	Type
	Number of units
	Max continuous power (kW)

5.3 Measuring instruments

5.3.1 Tab 7 indicates the suggested format for recording data relative to the measuring instruments.

5.4 Conditions during measurement

5.4.1 Tab 8 indicates the suggested format for recording data relative to the conditions during measuring.

5.5 Measuring results

5.5.1 The following tables are an outline of the general scheme in which the measurement positions of the climate are indicated.

Table 7 : Measuring instruments

Characteristics of instruments		
Instrument	Manufacturer	Type of instrument
Thermometer		
Anemometer		
Calibration of the thermometer	Date in laboratory	
	Date prior to measuring	
Calibration of the anemometer	Date in laboratory	
	Date prior to measuring	

Table 8 : Conditions during measurement

Conditions during measurements		
Date		
Starting time		
Finishing time		
Position of the ship		
Type of voyage		
Conditions during measurement	Draught forward (m)	
	Draught aft (m)	
	Depth water under keel (m)	
Weather conditions	Wind force / speed (Bf -m/s)	
	Sea state / average wave height (SS -m)	
Average outside air temperature		
Speed of the ship (knots)		
Propeller shaft speed (rev/min)		
Propeller pitch		
Propulsion machinery speed (rev/min)		
Propulsion machinery power (kW)		
No. of operating propulsion machineries		
No. of D/A operating engines		
No. of auxiliary machineries		

5.5.2 Tab 9, Tab 10, Tab 11 and Tab 12 are the suggested formats for recording the measurements carried out in suites or mini-suites, type C recreational spaces and hospitals.

5.5.3 Tab 13, Tab 14, Tab 15 and Tab 16 are the suggested formats for recording the measurements carried out in passenger cabins, type A, B and D spaces, wheelhouses, safety stations, control rooms.

Table 9 : Suites, mini-suites, type C recreational spaces and hospitals - Measurement in Winter conditions - Detail

Position number	Type of space	Area (m ²)	Humidity	AV _{meas}	Outside air temperature T _a	Measured ambient temperature (internal) T _{meas}	Corrected internal air temperature T _o (1)
1							
2							
3							
.....							
(1) Ambient temperature (internal) corrected in accordance with [3.2.4]							

Table 10 : Suites, mini-suites, type C recreational spaces and hospitals - Measurement in Winter conditions - Summary

Total number of measurements							
Operative temperatures			Air velocity			Humidity	
Measurement	Number	%	Measurement	Number	%	Max.	Min.
T _{max} -0,5≤T _o ≤T _{max} +1,5			AV _{meas} ≤ AV _{min}				
			AV _{meas} ≤ AV _{min} +0,05				
T _{max} -1≤T _o ≤T _{max} +1,5			AV _{meas} ≤ AV _{min} +0,05				
			AV _{meas} ≤ AV _{min} +0,10				
T _{min} ≤T _o ≤T _{max} +1,5			AV _{meas} ≤ AV _{max}				
T _{min} -1≤T _o ≤T _{max} +1,5			AV _{meas} ≤ AV _{max} +0,10				

Table 11 : Suites, mini-suites, type C recreational spaces and hospitals - Measurement in Summer conditions - Detail

Position number	Type of space	Area (m ²)	Humidity	AV _{meas}	Outside air temperature T _a	Measured ambient temperature (internal) T _{meas}	Corrected internal air temperature T _o (1)
1							
2							
3							
.....							
(1) Ambient temperature (internal) corrected in accordance with [3.2.4]							

Table 12 : Suites, mini-suites, type C recreational spaces and hospitals - Measurement in Summer conditions - Summary

Total number of measurements							
Operative temperatures			Air velocity			Humidity	
Measurement	Number	%	Measurement	Number	%	Max.	Min.
$T_{min}-0,5 \leq T_o \leq T_{min}+0,5$			$AV_{meas} \leq AV_{min}$				
			$AV_{meas} \leq AV_{min}+0,05$				
$T_{min}-0,5 \leq T_o \leq T_{min}+2,5$			$AV_{meas} \leq AV_{min}+0,05$				
			$AV_{meas} \leq AV_{min}+0,10$				
$T_{min}-0,5 \leq T_o \leq T_{max}$			$AV_{meas} \leq AV_{max}$				
$T_{min}-0,5 \leq T_o \leq T_{max}+1$			$AV_{meas} \leq AV_{max}+0,10$				

Table 13 : Passenger cabins, type A, B, D recreational spaces, wheelhouses, safety stations, control rooms - Measurement in Winter conditions - Detail

Position number	Type of space	Area (m ²)	Humidity	AV _{meas}	Outside air temperature T _a	Measured ambient temperature (internal) T _{meas}	Corrected internal air temperature T _o (1)
1							
2							
3							
.....							

(1) Ambient temperature (internal) corrected in accordance with [3.2.4]

Table 14 : Passenger cabins, type A, B, D recreational spaces, wheelhouses, safety stations, control rooms - Measurement in Winter conditions - Summary

Total number of measurements							
Temperatures			Air velocity			Humidity	
Measurement	Number	%	Measurement	Number	%	Max.	Min.
$T_{max}-1 \leq T_o \leq T_{max}+1,5$			$AV_{meas} \leq AV_{min}$				
			$AV_{meas} \leq AV_{min}+0,1$				
$T_{max}-1,5 \leq T_o \leq T_{max}+1,5$			$AV_{meas} \leq AV_{min}+0,1$				
			$AV_{meas} \leq AV_{min}+0,15$				
$T_{min} \leq T_o \leq T_{max}+1,5$			$AV_{meas} \leq AV_{max}$				
$T_{min}-1,5 \leq T_o \leq T_{max}+1,5$			$AV_{meas} \leq AV_{max}+0,15$				

Table 15 : Passenger cabins, type A, B, D recreational spaces, wheelhouses, safety stations, control rooms - Measurement in Summer conditions - Detail

Position number	Type of space	Area (m ²)	Humidity	AV _{meas}	Outside air temperature T _a	Measured ambient temperature (internal) T _{meas}	Corrected internal air temperature T _o (1)
1							
2							
3							
.....							
(1) Ambient temperature (internal) corrected in accordance with [3.2.4]							

Table 16 : Passenger cabins, type A, B, D recreational spaces, wheelhouses, safety stations, control rooms - Measurement in Summer conditions - Summary

Total number of measurements							
Operative temperatures			Air velocity			Humidity	
Measurement	Number	%	Measurement	Number	%	Max.	Min.
T _{min} -1<T _o <T _{min} +1			AV _{meas} ≤ AV _{min}				
			AV _{meas} ≤ AV _{min} +0,1				
T _{min} -1<T _o <T _{min} +3			AV _{meas} ≤ AV _{min} +0,1				
			AV _{meas} ≤ AV _{min} +0,15				
T _{min} -1<T _o <T _{max} +0,5			AV _{meas} ≤ AV _{max}				
T _{min} -1<T _o <T _{max} +1,5			AV _{meas} ≤ AV _{max} +0,15				

5.5.4 Tab 17, Tab 18, Tab 19 and Tab 20 are the suggested formats for recording the measurements carried out in all other spaces in passenger and heavy cargo ships.

Table 17 : Other spaces - Measurement in Winter conditions - Detail

Position number	Type of space	Area (m ²)	Humidity	AV _{meas}	Outside air temperature T _a	Measured ambient temperature (internal) T _{meas}	Corrected internal air temperature T _o (1)
1							
2							
3							
.....							
(1) Ambient temperature (internal) corrected in accordance with [3.2.4]							

Table 18 : Other spaces - Measurement in Winter conditions - Summary

Total number of measurements							
Operative temperatures			Air velocity			Humidity	
Measurement	Number	%	Measurement	Number	%	Max.	Min.
$T_{max}-1,5 \leq T_o \leq T_{max}+1,5$			$AV_{meas} \leq AV_{min}$				
			$AV_{meas} \leq AV_{min}+0,15$				
$T_{max}-2 \leq T_o \leq T_{max}+1,5$			$AV_{meas} \leq AV_{min}+0,15$				
			$AV_{meas} \leq AV_{min}+0,2$				
$T_{min}-0,5 \leq T_o \leq T_{max}+1,5$			$AV_{meas} \leq AV_{max}+0,05$				
$T_{min}-2 \leq T_o \leq T_{max}+1,5$			$AV_{meas} \leq AV_{max}+0,2$				

Table 19 : Other spaces - Measurement in Summer conditions - Detail

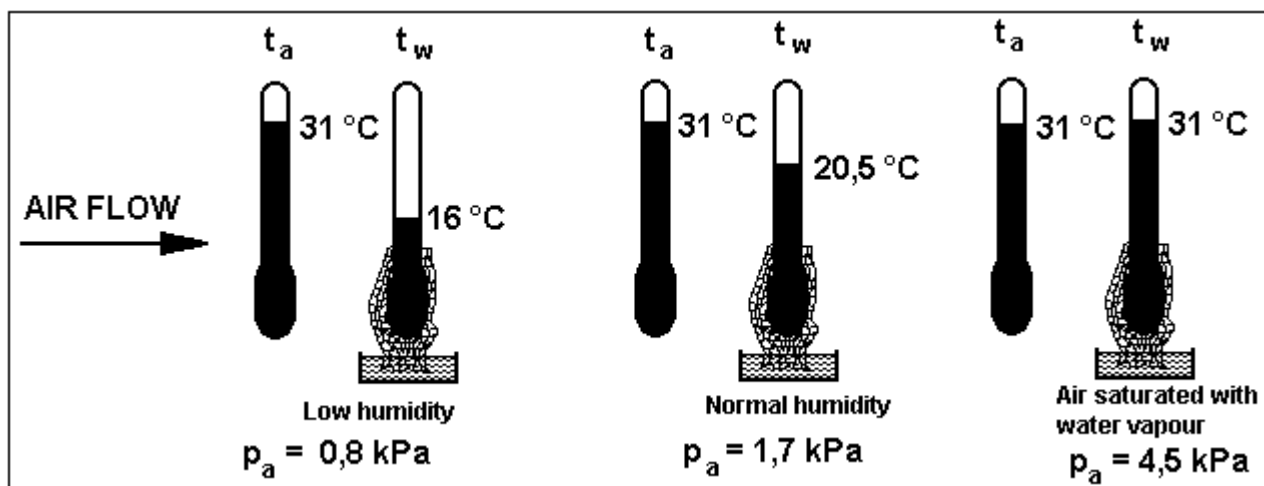
Position number	Type of space	Area (m ²)	Humidity	AV_{meas}	Outside air temperature T_a	Measured ambient temperature (internal) T_{meas}	Corrected internal air temperature T_o (1)
1							
2							
3							
.....							

(1) Ambient temperature (internal) corrected in accordance with [3.2.4]

Table 20 : Other spaces - Measurement in Summer conditions - Summary

Total number of measurements							
Operative temperatures			Air velocity			Humidity	
Measurement	Number	%	Measurement	Number	%	Max.	Min.
$T_{min}-1,5 \leq T_o \leq T_{min}+1,5$			$AV_{meas} \leq AV_{min}$				
			$AV_{meas} \leq AV_{min}+0,15$				
$T_{min}-1,5 \leq T_o \leq T_{min}+3,5$			$AV_{meas} \leq AV_{min}+0,15$				
			$AV_{meas} \leq AV_{min}+0,2$				
$T_{min}-1,5 \leq T_o \leq T_{max}+1$			$AV_{meas} \leq AV_{max}+0,05$				
$T_{min}-1,5 \leq T_o \leq T_{max}+2$			$AV_{meas} \leq AV_{max}+0,2$				

Figure 4 : Principle of operation of a psychrometer



6 Measurement of humidity

6.1 Measuring of the absolute humidity using psychrometry

6.1.1 Principles

- A psychrometer consists of two thermometers and a device to ensure ventilation of the thermometers at a minimum air velocity (see Fig 4).
- The first thermometer is an ordinary thermometer indicating the air temperature t_a . This will be referred to as the "dry" temperature of the air as opposed to the "wet" temperature indicated by the second thermometer.
- The latter consists of a thermometer surrounded by a wet wick generally made from close-meshed cotton. The end of the wick lies in a container of water. The water is raised by capillary attraction from the container to the thermometer and then evaporates at a rate dependent upon the humidity of the air. This results in a greater cooling of the thermometer the drier the air (this cooling is limited by the heat transfer due to air convection). The temperature indicated by the thermometer surrounded by the wet wick is referred to as the wet temperature (psychrometric) t_w .
- The observed dry temperature and wet temperature are used in the determination of the absolute humidity of the air.

6.1.2 Precaution to be taken using a psychrometer

- Unless proper precautions are taken during measurement, the simplicity of the principle and the use of a psychrometer can lead to very considerable measuring errors.
- The psychrometric wet temperature is not to be confused with the natural wet temperature which is measured using a naturally ventilated sensor with a wet wick.
- The wet thermometer is to be ventilated at a sufficient velocity generally at least within 4 or 5 m/s. The air may be renewed either by rapidly moving the wet thermometer manually in the environment (whirling psychrome-

ter), or by sucking air with a microturbine or a small ventilator driven by an electric or mechanical motor. In general, small sized temperature sensors require lower minimum air velocities.

- The dry and wet thermometers are to be protected from radiation by a screen. When the mean radiant temperature is higher or lower than the air temperature, the air temperature sensor is to be protected by using one or more screens. As the wet temperature may also be different from the mean radiant temperature, it is important that the thermometer be protected.
- The wick around the wet thermometer is to extend beyond the sensitive part of the sensor in order eliminate errors due to thermal conduction in the thermometer. If this precaution is not taken, the sensitive part of the sensor cooled by evaporation is at the wet temperature, whereas the non-sensitive part, not being cooled, is at the air temperature. This results in a transfer of heat conduction between the two parts and consequently in an error in the measurement of the wet temperature. The wet wick is therefore to extend sufficiently far along the thermometer to cool the thermometer beyond the sensitive part. Tab 21 indicates the wick lengths which have been recommended for different types of thermometer.
- The water wetting the wick is to be distilled water, since the water vapour pressure in the case of salt solutions is less than that in the case of pure water.
- The wick of the wet thermometer is to allow the water to circulate easily by capillary attraction particularly when the absolute humidity of the air is low. In the latter condition, the increased evaporation of water at the thermometer requires the water to rise quickly from its reservoir. The wick is to be replaced, if soiled.
- It is necessary to measure the barometric pressure when this deviates perceptibly (2 %) from 101,3 kPa. As the phenomenon of evaporation depends on the atmospheric pressure (variable in particular as a function of altitude), it is necessary to use charts corresponding to the barometric pressure measured.

Table 21

Type	Diameter (mm)	Wick length (mm)
Mercury thermometer	All	20 (above the bulb)
Thermocouple	1,2	60
	0,45	30
	0,12	10

6.2 Relative humidity

6.2.1

- a) The values giving the composition of the air in terms of water vapour in relation to the maximum amount it can hold at a given temperature characterise the relative humidity of the environment.

- b) The relative humidity e is the ratio between the partial pressure of water vapour p_a , in humid air and the water vapour saturation pressure p_{as} at the same temperature and the same total pressure.

$$e = \frac{p_a}{p_{as}}$$

- c) The relative humidity is often expressed as a percentage in accordance with the following relationship:

$$RH = 100 \cdot e$$

- d) With regard to the heat transfer between man and his environment by evaporation, it is the absolute humidity of the air which needs to be taken into account.

SECTION 4

COMFORT WITH REGARD TO NOISE IN PORT AREA

1 General

1.1 Application

1.1.1 (1/1/2020)

COMF-NOISE-PORT(X) notation, in accordance with Pt A, Ch 1, Sec 2, [6.7.5], is assigned to ships classed by the Society and complying with the requirements of this Section. In the event that the ship undergoes modifications, refitting or repairs that may affect its level of comfort, the maintenance of the notation is subject to the results of new measurements as deemed appropriate by the Society. The notation is completed by a number (1-100) which represents the merit level achieved for the assignment of the notation, the merit 100 corresponding to the lowest level of noise.

The notation **COMF-NOISE-PORT(X)** is only assigned if at least merit level 1 is reached.

1.1.2 (1/1/2020)

Ships not classed by the Society complying with the requirements of this Section are provided with a Certificate of Conformity which attests their comfort quality. The Certificate is valid for a period of 5 years and may be extended, at the request of the Owner, for an additional 5-year period based on a limited set of measurements covering at least 5% of those made when the Certificate was first issued.

1.1.3 (1/1/2020)

The requirements apply to conventional passenger and cargo ships irrespective of the ship's age, as far as reasonable and practicable, to the satisfaction of the Society.

1.2 Basic principles

1.2.1 (1/1/2020)

The requirements of this Section define the limits of acceptability of noise in port area, the methods for verification of compliance and the criteria for acceptance. They are based, as appropriate, on international standards and are deemed to preserve the general principles of such standards.

1.2.2 (1/1/2020)

Verification of compliance is based on the measurements of noise levels outside the ship at a distance of 100m. These measurements are to be carried out either by a Surveyor of the Society or by a technician from a company recognized as suitable by the Society. In the latter case, measurements are to be performed under the surveillance of a Surveyor of the Society.

2 Definitions

2.1 Noise

2.1.1 (1/1/2020)

Noise is the audible sound wave level, generally of a random nature, in the 20 to 18000 Hz frequency range. As far as compliance with the requirements of this Section is concerned, noise is measured in the 31,5 to 8000 Hz frequency range unless otherwise specified by the Society in special cases.

2.1.2 (1/1/2020)

For the purposes of this Section, A-weighted noise levels are considered, measured in dB(A) by a precision sound level meter with an accuracy grade of about ± 1 dB.

3 Documentation to be submitted

3.1 Measurement plan

3.1.1 (1/1/2020)

The proposed measurement plan is to be submitted for information well in advance of the measurement campaign. The measurement plan should provide information (position, technical data sheets, etc.) of all possible noise sources during the described measurement condition.

3.2 Noise measurement results

3.2.1 (1/1/2020)

A detailed measurement report is to be submitted for approval.

4 Noise levels: testing conditions and acceptance criteria

4.1 Testing conditions

4.1.1 General (1/1/2020)

Noise levels are to be measured according to ISO 2922:2000 in the conditions defined below. Different conditions may be accepted as equivalent at the discretion of the Society.

4.1.2 General (1/1/2020)

During measurements, all auxiliary systems, forced ventilation and air conditioning systems (HVAC systems) and hotel service systems are to be operating in idle conditions; as noise arising from every kind of human activity (included cargo load and unload) is to be avoided, in general only the personnel needed for the operation of the ship hotel activities and those carrying out the measurements are to be pres-

ent. During measurements all passenger entertainment systems are to be switched off.

4.1.3 General (1/1/2020)

As far as practicable the ship position should be the worst possible one from the acoustic point of view (e.g. with noise sources facing the port area). The position during test should be reported in the measurement report.

4.1.4 General (1/1/2020)

In general, meteorological conditions are to be within the following limits:

- wind: not stronger than Beaufort 4 - strong breeze (speed 11 to 16 knots).

4.1.5 Propulsive Power (1/1/2020)

The vessel is to be at rest in port with the propulsion engines switched off and only the minimum number of necessary auxiliary systems running. Engine room ventilation is to be running in normal mode.

Different conditions may be considered if accepted as equivalent for the purpose of the requirements at the discretion of the Society.

4.1.6 Other equipment (1/1/2020)

All machineries necessary for cargo (such as garage ventilation fans for Ro-Ro Ships, Refeers fans for Container ships, etc.) are running in normal mode.

Subject to the acceptance of the Society and to the agreement of the interested party, equipment such as bow thrusters, stabilizing fins etc. is to be operating during measurements, if it is necessary for the ship in normal operating conditions and in the environmental conditions specified in [4.1.4].

With the above-mentioned equipment operating, special consideration may be given by the Society concerning the acceptable noise levels.

4.2 Measurement positions

4.2.1 (1/1/2020)

Measurements are to be carried out in correspondence of the potential noise sources (exhaust funnel outlets of the auxiliary engines, outlet fan/ventilation, pumps, compressors, public address systems, ect.) according to the following principles.

At the discretion of the Society, additional measurements are to be performed to establish the extension of area with excessive noise levels.

4.2.2 (1/1/2020)

Measurements should be carried out at a distance of 100 m from the ship surface. All measurement points shall be at least 4 m above the sea surface.

4.2.3 (1/1/2020)

If, for logistical or geographical reasons, such a distance (100 m) from the ship is not practicable, a different distance could be considered. The measured data will be corrected for distance in the post processing phase as described in [5.3].

4.3 Instrumentation

4.3.1 (1/1/2020)

Noise level measurements are to be carried out by means of integrating-averaging sound precision level meters. These sound level meters are to comply with IEC 60942 (2003-01) or a standard accepted as equivalent by the Society.

This compliance is to be verified according to ISO 17025 (2005) at least every two years by an organization recognized by the Society.

The date of last verification and confirmation of compliance with relevant IEC standards is to be recorded. Calibration sheets are to b1e provided.

4.4 Measurement procedure

4.4.1 (1/1/2020)

Distance measurement is required to determine the distance between the ship surface and the measurement point. If such a distance will be different from 100 m a correction, during the post processing phase, will be applied [5.3].

4.4.2 (1/1/2020)

Measurements are to be carried out to estimate the sound pressure levels LAeq by averaging the noise level during at least 15 s with the time-weighting slow (S). If the sound is irregular with fluctuations exceeding ± 3 dB(A), the measuring time is to be extended to at least 30 s. The measured value is to be rounded to the nearest integer. Noise level is to be measured in dB (A) units with the A-weighting curve.

4.4.3 (1/1/2020)

The recommended distance between the ship hull side/stern and the microphone should be 100 m. The vessel side should be directly exposed to the microphone, no barriers should be placed between the source (ship) and the receiver (microphone).

4.4.4 (1/1/2020)

At least three (3) noise measurements for each side (starboard and portside) of the vessel should be carried out. One point should be in correspondence of the Midship Perpendicular, the others two $\frac{1}{4}$ of the ship overall length fore and aft the Midship Perpendicular.

4.4.5 (1/1/2020)

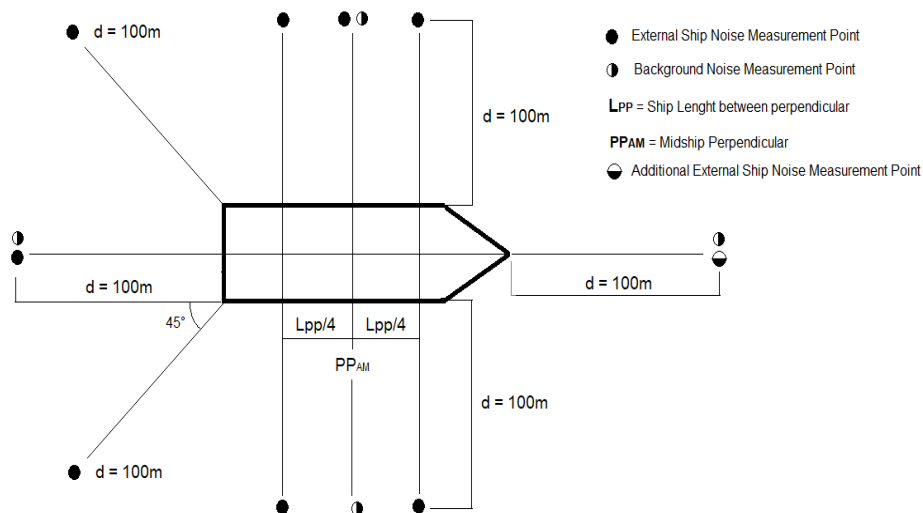
At least one (3) noise measurement for the aft part of the vessel should be carried out. One point should be in correspondence of the center line, the others two in correspondence of the stern edges (one starboard side, one port side) as described in the following figure.

4.4.6 (1/1/2020)

One (1) additional point could be measured in correspondence of the bow of the vessel if a significant noise from the fore part is present. In any case, the additional fore measurement point could be requested at the discretion of the Society during measurements.

In case the additional measurement point is requested, a background noise measurement in the same position should also be carried out.

Figure 1 (1/1/2020)



4.4.7 (1/1/2020)

The resulting data set will be composed by:

- $L_{Aeq,S,n}$ = Starboard side measurement at 100 m from the hull side. Where $n = 1, 2, 3$ (number of measurements for each side)
- $L_{Aeq,P,n}$ = Port side measurement at 100 m from the hull side. Where $n = 1, 2, 3$ (number of measurements for each side)
- $L_{Aeq,A,n}$ = Aft part measurement at 100 m from the hull side. Where $n = 1, 2, 3$ (number of measurements for stern area)

4.4.8 (1/1/2020)

The background noise is the noise from all acoustical and non-acoustical sources when the ship is not present.

A background noise recording ($L_{Aeq,BG}$) has to be carried out before or after the noise measurements.

At least one background noise measurement for each side of the vessel and one for the stern area are required.

5 Post processing

5.1 Introduction

5.1.1 (1/1/2020)

When the testing is completed, post processing is required to adjust sound pressure level spectra for background noise, distance and to combine multiple measurements.

5.2 Background noise adjustments

5.2.1 (1/1/2020)

The signal plus noise to noise ratio, or ΔL , is defined as follows for each measurement:

$$\Delta L = L_{Aeq,n} - L_{Aeq,BG}$$

where:

$L_{Aeq,n}$ = measured sound pressure level measured

$L_{Aeq,BG}$ = measured background noise in the corresponding point of measurement.

5.2.2 (1/1/2020)

If ΔL is greater than 10 dB, then no adjustments are necessary. If ΔL is between 3 and 10 dB and if the background noise is sufficiently stationary, then adjustments to the measurements are required.

The adjustment consists in subtracting the following coefficient K_1 to the measured sound pressure level.

$$K_1 = -10 \log (1 - 10^{-10\Delta L})$$

5.2.3 (1/1/2020)

It is to be clearly identified in the report that such corrections have been applied. If ΔL is less than 3 dB then the data are to be so noted or discarded.

5.3 Distance normalization

5.3.1 (1/1/2020)

The final adjustment is normalization for distance. The typical distance from the ship to the measurement point is 100 m. However, because of logistical and geographical reasons, this distance may vary.

5.3.2 (1/1/2020)

The distance normalized sound pressure level is determined by adding to the measured sound pressure level the following coefficient K_2 .

$$K_2 = 20 \log (d/d_{ref})$$

where:

d = is the distance from the ship under test to measuring point (meters);

d_{ref} = reference distance of 100 m

5.4 SPL measurements combination

5.4.1 (1/1/2020)

The multiple measurements are to be combined through an energetic mean of the recorded sound pressure levels A-weighted.

5.4.2 (1/1/2020)

The first step is to determine the average of the sound pressure level A weighted from all three measurements at the same side/stern of the ship.

$$L_{Aeq,S} = 10 \log \left[\frac{1}{N} \sum_n 10^{\frac{L_{Aeq,S,n}}{10}} \right]$$

$$L_{Aeq,P} = 10 \log \left[\frac{1}{N} \sum_n 10^{\frac{L_{Aeq,P,n}}{10}} \right]$$

$$L_{Aeq,A} = 10 \log \left[\frac{1}{N} \sum_n 10^{\frac{L_{Aeq,A,n}}{10}} \right]$$

where:

$L_{Aeq,S}$ = A-weighted averaged starboard side sound pressure level.

$L_{Aeq,P}$ = A-weighted averaged portside sound pressure level.

$L_{Aeq,A}$ = A-weighted averaged aft area sound pressure level.

$L_{Aeq,S,n}$ = A-weighted starboard side sound pressure level measurements at 100 m from the hull side at the requested positions in [4.4.4]. This value is already post processed for background noise and distance.

$L_{Aeq,P,n}$ = A-weighted portside sound pressure level measurements at 100 m from the hull side at the requested positions in [4.4.4]. This value is already post processed for background noise and distance.

$L_{Aeq,A,n}$ = A-weighted aft area sound pressure level measurements at 100 m from the stern at the requested positions in [4.4.5].

N = number of measurement at each side of the ship. As described in [4.4.4] and [4.4.5]. N should be at least three (3).

5.4.3 (1/1/2020)

The final A-weighted sound pressure level (L_{Aeq}) is an average between the two sides averaged sound pressure levels and the aft side averaged sound pressure level.

$$L_{Aeq} = 10 \log \left[\frac{1}{3} \left(10^{\frac{L_{Aeq,S}}{10}} + 10^{\frac{L_{Aeq,P}}{10}} + 10^{\frac{L_{Aeq,A}}{10}} \right) \right]$$

where:

$L_{Aeq,S}$ = A-weighted averaged starboard side sound pressure level.

$L_{Aeq,P}$ = A-weighted averaged portside sound pressure level.

$L_{Aeq,A}$ = A-weighted averaged aft part sound pressure level.

5.4.4 (1/1/2020)

For the purposes of these Rules, the merit level X, defined in [1.1.1], is calculated by the following procedure:

a) the noise merit parameter, Cmr, is calculated by linear interpolation as follows:

$Cmr = 0$ if $L_{Aeq} > L_{max}$

$Cmr = 1 - (L_{Aeq} - L_{min}) / (L_{max} - L_{min})$ if $L_{min} \leq L_{Aeq} \leq L_{max}$

$Cmr = 1$ if $L_{Aeq} < L_{min}$

where:

L_{Aeq} : final A-weighted sound pressure level representative of the ship external noise emitted at 100 m

L_{min} : lower bound for the noise level (Tab 1)

L_{max} : upper bound for the noise level (Tab 1)

b) the noise merit level, X, is the noise merit parameter, Cmr, times 100.

Table 1 : External Noise Limits at 100 m (1/1/2020)

	L_{min}	L_{max}
	[dB(A)]	[dB(A)]
External Noise Limit at 100 m	45	65

Note 1: External Noise Limits have been calculated based on "Environmental Noise Guidelines for the European Region" developed by World Health Organization in 2018.

6 Reporting example

6.1

6.1.1 (1/1/2020)

The test report is to include all the information and data required to verify the fulfilment of the notation.

The minimum set of information is to be agreed with the Society before carrying out the trials.

Results are to be submitted in a report which includes:

- the main characteristics of the ship and of the measurement instrumentation;
- the main characteristics of the port of measurements (satellite image of the port with highlighted ship position is recommended);
- the noise measurements plan;
- a summary table showing, for each measurement carried out, the recorded noise levels and all post processing corrections carried out.

7 Assignment criteria

7.1

7.1.1 (1/1/2020)

The additional class notation is assigned to all ships reaching a merit parameter (X) equal or greater than 1.

Part F
Additional Class Notations

Chapter 7

POLLUTION PREVENTION (CLEAN)

- | | |
|-------------------|--|
| SECTION 1 | SEA AND AIR POLLUTION PREVENTION (GREEN PLUS) |
| SECTION 2 | SEA AND AIR POLLUTION PREVENTION (GREEN STAR 3 DESIGN) |
| SECTION 3 | AIR POLLUTION PREVENTION (CLEAN-AIR) |
| SECTION 4 | SEA POLLUTION PREVENTION (CLEAN-SEA) |
| SECTION 5 | SEA AND AIR POLLUTION PREVENTION (GREEN STAR 3) |
| SECTION 6 | GREEN AND CERTIFIED CARGO HANDLING SYSTEMS (GC CARGO HANDLING SYSTEM) |
| APPENDIX 1 | DEFINITIONS RELEVANT THE GREEN PLUS NOTATION |
| APPENDIX 2 | BASIC AND ADDITIONAL SYSTEMS, COMPONENTS AND PROCEDURAL MEANS TO EVALUATE THE SHIP'S ENVIRONMENTAL INDEX AS PER THE GREEN PLUS NOTATION |
| APPENDIX 3 | STANDARDS SPECIFICATIONS FOR SHIPBOARD INCINERATORS (IMO RESOLUTION MEPC.76(40) ADOPTED ON 25 SEPTEMBER 1997) |

SECTION 1 SEA AND AIR POLLUTION PREVENTION (GREEN PLUS)

1 General

1.1 Application

1.1.1

The additional class notation **GREEN PLUS** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.8.4] a), to:

- sea going ships
- ships intended to operate at a fixed location
- barges not provided with machinery spaces,

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], [6.2] and [6.3] as applicable.

Solid cargo handling systems which may be a source of sea or air pollution (e.g. those handling coal, iron ore, sulphur, etc.) are to be designed to minimize their environmental impact according to Sec 6, [3].

The additional class notation **GREEN PLUS T** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.8.4] b), to ships intended to operate at a fixed location, complying with **GREEN PLUS** and Sec 6 requirements.

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

Definitions are those given in:

- MARPOL 73/78 as amended and
- App 1.

3 Documents to be submitted

3.1

3.1.1

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 (1/1/2020)

No.	A/I (1)	Document
1	I	Ship Environmental Management Plan
2	A	Drawings with indication of capacities of fuel, sludge and lubricating oil tanks and distances from the base line and shell plates
3	A	Tank general arrangement plan showing the bilge tanks, their capacities and alarms
4	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
5	I	Plans of systems and equipment to discharge harmful substances in case of emergency and to dispose of and wash possible leaks
6	A	Tank general arrangement plan showing the treated sewage holding tanks, their capacities and their alarms
7	I	Tank general arrangement plan showing the grey water holding tanks, their capacities and relevant alarms
8	A	Ballast water management plan
9	A	Garbage management plan including information on garbage treatment equipment and its control and monitoring system and best practice about the use of plastic onboard, if any
10	I	General arrangements of refrigeration plants including the indication of retention facilities
(1) A = to be submitted for approval in four copies; I = to be submitted for information in duplicate.		

No.	A/I (1)	Document
11	I	Data sheets with list of intended refrigerants to be used in the different refrigeration systems, their quantities and their GWP and ODP
12	I	Data sheets with the list of fixed fire-fighting means used, their quantities and GWP values
13	I	Detailed plans of systems and equipment to limit SOx emission
14	I	Drawings of fuel oil system, arrangements and procedures for use of separate fuel oil
15	A	Inventory of Hazardous Materials (IHM)
16	A	EEDI calculation
17	I	Hull transom design study
18	I	Calculation relevant to high performing propellers
19	I	Study for the reduction of fuel
20	I	Noise assessment and measurements
21	I	Visual impact assessment
22	I	Illumination plan and Light pollution assessment
23	I	Environmental Risk Assessment (ERA)
(1) A = to be submitted for approval in four copies; I = to be submitted for information in duplicate.		

4 Requisites

4.1 General requirements

4.1.1

A Ship Environmental Manager, as defined in App 1, [1.2], is to be appointed and present on board (for barges not provided with machinery spaces, the presence of the Ship Environmental Manager on board is not required).

4.1.2

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 2, [3].

4.1.3

Adequate training on environmental issues is to be planned, carried out and documented for all the persons on board having influence on the environmental behavior of the ship.

4.2 Basic systems, components and procedural means

4.2.1

Basic systems, components and procedural means, a ship is to be equipped with, are those defined in the requirements of the IMO Conventions in force, as applicable to the ship.

4.3 Additional systems, components and procedural means

4.3.1

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.

Table 2 : Additional systems, components and procedural means (1/1/2020)

No.	Pollution source	Item	Environmental index	References (App 2)
1	Oil from Machinery Spaces	Bilge Water Treatment (15 ppm with alarm and automatic stop)	2 (1)	[1.1.1]
		Bilge Water Treatment (5 ppm with alarm and automatic stop)	5 (1)	[1.1.2]
		Bilge Water Treatment (5 ppm with alarm, automatic stop and recorder)	7 (1)	[1.1.3]
		Bilge oil tank	2 (2)	[1.1.4]
		Retention on board	8 (2)	[1.1.5]
		Restrictions in the use of ship's fuel tanks for ballast	1	[1.1.6]
		Fuel oil tank protection by means of tank boundary distance from the ship side and bottom	8 (3)	[1.1.7]
		Fuel oil tank protection by means of outflow calculation	5 (3)	[1.1.8]
		Lubricating oil and sludge tank protection by means of tank boundary distance from the ship side and bottom	7 (4)	[1.1.9]
		Lubricating oil and sludge tank protection by means of outflow calculation	5 (4)	[1.1.10]
		Oil tank overflow	1	[1.1.11]
		Gutters	1	[1.1.12]
		Dry bilge concept	3	[1.1.13]
		Sludge oil collection and handling facilities	2	[1.1.14]
		Water-lubricated stern tube bearings	5	[1.1.15]
		Magnetic coupling on oil pumps	5	[1.1.16]
		Biodegradable and low aquatic toxicity lube oil	5	[1.1.17]
		Restriction in the use of hydraulic plants	7	[1.1.18]
		Electronic Oil Record Book	1 (16)	[1.1.19]
2	Solid bulk cargo storage	Systems to minimize the dispersion of cargo environmentally hazardous dusts	10	[1.2.1]
		Cargo moisture level increasing systems	15	[1.2.2]
3	Sewage	Treatment plant: effluent quality as per IMO MEPC.2(VI)	2 (4)	[1.3.1]
		Treatment plant: effluent quality as per IMO MEPC.159(55)	3 (5)	[1.3.2]
		Treatment plant: effluent quality as per IMO MEPC.227(64) except for paragraph [4.2]	5 (5)	[1.3.3]
		Treatment plant: effluent quality as per IMO MEPC.227(64) including paragraph [4.2]	6 (5)	[1.3.4]
		Holding tank	3 (5)	[1.3.5]
		Retention on board	5 (5)	[1.3.6]
		Sewage record book	2 (7)	[1.3.7]
		Electronic sewage record book	1 (7)(16)	[1.3.8]
<p>(1) to (13) With reference to the items where a note (1) to (13) appears, only one corresponding environmental index is assignable. (14) applicable only to ships intended to operate at a fixed location. (15) to be weighted. (16) not valid for number of pollution sources calculation as requested in [6.1.1] b), [6.2.1] b), [6.3.1] b)</p>				

No.	Pollution source	Item	Environmental index	References (App 2)
4	Grey water	Treatment plant: effluent quality as per IMO MEPC.2(VI)	3 (8)	[1.4.1]
		Treatment plant: effluent quality as per IMO MEPC.159(55)	4 (8)	[1.4.2]
		Treatment plant: effluent quality as per IMO MEPC.227(64) except for paragraph [4.2]	5 (8)	[1.4.3]
		Treatment plant: effluent quality as per IMO MEPC.227(64) including paragraph [4.2]	6 (8)	[1.4.4]
		Holding tank	3 (9)	[1.4.5]
		Retention on board	5 (9)	[1.4.6]
		Grey water record book	2	[1.4.7]
		Electronic Grey water record book	1 (16)	[1.4.8]
5	Garbage	Garbage Management Plan	2	[1.5.1]
		Recycling	5	[1.5.2]
		Advanced recycling	10	[1.5.3]
		Electronic Garbage Record Book	1 (16)	[1.5.4]
		Plastic litter	10 (15)	[1.5.5]
6	Other sources	Ballast water treatment	5 (10)	[1.6.1]
		Ballast water treatment without chemical	10 (10)	[1.6.2]
		Marine growth prevention systems	3	[1.6.3]
		Collection of spillage/ leakage of environmental hazardous substances	3	[1.6.4]
		Biodegradable and low aquatic toxicity lubricants	3	[1.6.5]
		Limitation of hot water discharge (12)	5	[1.6.6]
		Retention of dirty water from cargo area	7	[1.6.7]
		Electronic Cargo Record Book	1 (16)	[1.6.8]
		Electronic Ballast Water Record Book	1 (16)	[1.6.9]
		Bleed-off water from Exhaust Gas Recirculation	5	[1.6.10]
		Biofouling Management Plan	3	[1.6.11]
7	Ozone-depleting substances	Refrigerating facilities	5	[2.1.1]
		Electronic Ozone-depleting Substances Record Book	1 (16)	[2.1.2]
		Restrictions in the use of GWP substances	10 (15)	[2.1.3]
		Refrigerating system without fluorinated greenhouse gases	10	[2.1.4]
<p>(1) to (13) With reference to the items where a note (1) to (13) appears, only one corresponding environmental index is assignable. (14) applicable only to ships intended to operate at a fixed location. (15) to be weighted. (16) not valid for number of pollution sources calculation as requested in [6.1.1] b), [6.2.1] b), [6.3.1] b)</p>				

No.	Pollution source	Item	Environmental index	References (App 2)
8	Green house gases and pollutants	Non fossil fuels (use of electric power generators and/or propulsion systems that do not use prime movers generating GHGs and pollutants (e.g. sails, fuel cells, etc.))	30 (15)	[2.2.1]
		Second generation of bio-fuels	20 (15)	[2.2.2]
		Cold ironing	2 (11)	[2.2.3]
		Zero emissions in port	5 (11)	[2.2.4]
		Tool to manage handling and consumption of fuels	2	[2.2.5]
		Computerized system to monitor fuel consumption	3	[2.2.6]
		Support tool to assist the Master in keeping most efficient sailing draft and trim	10 (12)	[2.2.7]
		Energy saving and energy conservation	5	[2.2.8]
		Fuel Consumption Decision Support Solution	10 (12)	[2.2.9]
		Optimization of Air Conditioning (AC) plant (including passive means to decrease AC demand, e.g. reflective glazing)	3	[2.2.10]
		Low energy consumption lights	3	[2.2.11]
		Variable speed drives	3	[2.2.12]
		Hull transom design (adoption of means capable to increase propulsion efficiency by minimum 0,5% at design speed)	3	[2.2.13]
		Stabilizer openings	3	[2.2.14]
		Silicone-based antifouling paint	10	[2.2.15]
		Fluoropolymer antifouling paint	15	[2.2.16]
		Fins on propeller boss cups	3	[2.2.17]
		High-performing propellers (capable to increase propulsion efficiency by minimum 1%)	5	[2.2.18]
		Installation of high efficiency (IE2) and premium efficiency (IE3) motors	3 (15)	[2.2.19]
Air lubrication system	3	[2.2.20]		
9	NOx	Gas to liquids (GTL) fuels (NOx emission lower than the limits as per Annex VI to MARPOL 73/78 as amended from prime movers and auxiliary boilers)	15 (15)	[2.3.1]
		Fossil fuel pre-treatment (e.g. water emulsion), or water injection into combustion chamber, or scavenging air, or combination of these (NOx emissions lower than the limits as per Annex VI to MARPOL 73/78 as amended from prime movers and auxiliary boilers)	10 (15)	[2.3.2]
		Dual-fuel engines running with LNG (NOx emissions lower than the limits as per Annex VI to MARPOL 73/78 as amended from prime movers)	15	[2.3.3]
		Exhaust gas treatment (abatement of not less than 85% of total generated NOx by prime movers)	20	[2.3.4]
		NOx emissions monitoring and recording	3	[2.3.5]
		Electronic Record Book of Engine Parameters	1 (16)	[2.3.6]
		Electronic tier and on/off status of marine diesel engines Record Book	1 (16)	[2.3.7]
<p>(1) to (13) With reference to the items where a note (1) to (13) appears, only one corresponding environmental index is assignable. (14) applicable only to ships intended to operate at a fixed location. (15) to be weighted. (16) not valid for number of pollution sources calculation as requested in [6.1.1] b), [6.2.1] b), [6.3.1] b)</p>				

No.	Pollution source	Item	Environmental index	References (App 2)
10	SOx	SOx limits (0,1%)	10	[2.4.1]
		Gas to liquids (GTL) fuels	10 (15)	[2.4.2]
		Blending fossil fuel with second-generation bio-fuels	10 (15)	[2.4.3]
		Dual-fuel engines running with LNG (gasoil only used as back-up in an emergency)	10	[2.4.4]
		Exhaust gas treatment (abatement of not less than 85% of total generated SOx by prime movers)	20	[2.4.5]
		SOx emissions monitoring and recording	3	[2.4.6]
		Electronic Fuel Oil Changeover Record Book	1 (16)	[2.4.7]
11	Particulates	Gas to liquids (GTL) fuels (lower PMs emissions)	20 (15)	[2.5.1]
		Fuel treatment (lower PMs emissions achieved by fossil fuel pre-treatment (e.g. water emulsion), or blending of pre-treated fossil fuel with second-generation bio-fuels, or combination of these)	15 (15)	[2.5.2]
		Lower PMs emission achieved by modifications in prime movers (e.g. common rail) that do not increase other pollutants and GHGs emissions	15 (15)	[2.5.3]
		Dual-fuel engines running with LNG (gasoil only used as back-up in emergency)	20	[2.5.4]
		Exhaust gas treatment (abatement of not less than 85% of total generated PMs by prime movers)	10	[2.5.5]
12	CO ₂	Gas to liquids (GTL) fuels (reduction in CO ₂ emission)	10 (15)	[2.6.1]
		Blending fossil fuel with second-generation bio-fuels (reduction in CO ₂ emission)	10 (15)	[2.6.2]
		Dual-fuel engines running with LNG (gasoil only used as back-up in emergency)	5	[2.6.3]
		CO ₂ monitoring and recording	3	[2.6.4]
		Attained Energy Efficiency Design Index (EEDI) ≤ Required EEDI (Phase 2)	2 (13)	[2.6.5]
		Attained Energy Efficiency Design Index (EEDI) ≤ Required EEDI (Phase 3)	4 (13)	
13	Noise	Noise level assessment and implementation of the noise mitigation measures	10	[2.7.1]
14	Visual intrusion (14)	Visual impact assessment and implementation of the esthetical mitigation measures	3	[2.8.1]
		Light pollution assessment and mitigation	5	[2.8.2]
<p>(1) to (13) With reference to the items where a note (1) to (13) appears, only one corresponding environmental index is assignable.</p> <p>(14) applicable only to ships intended to operate at a fixed location.</p> <p>(15) to be weighted.</p> <p>(16) not valid for number of pollution sources calculation as requested in [6.1.1] b), [6.2.1] b), [6.3.1] b)</p>				

No.	Pollution source	Item	Environmental index	References (App 2)
15	Assessment and monitoring (14)	Environmental Risk Assessment (ERA)	5	[2.9.1]
		Annual monitoring of air quality	2	[2.9.2]
		Annual monitoring of seawater quality	2	[2.9.3]
		Annual monitoring of terrestrial and marine flora	2	[2.9.4]
		Annual monitoring of terrestrial and marine fauna, including migrant animals	2	[2.9.5]
		Periodic ambient and underwater noise monitoring and recording	2	[2.9.6]
16	Ship at scrap	Ship recycling - HK Inventory of Hazardous Materials (HK IHM)	5	[2.10.1]
		Ship recycling - EU Inventory of Hazardous Materials (EU IHM)	7	[2.10.2]
<p>(1) to (13) With reference to the items where a note (1) to (13) appears, only one corresponding environmental index is assignable. (14) applicable only to ships intended to operate at a fixed location. (15) to be weighted. (16) not valid for number of pollution sources calculation as requested in [6.1.1] b), [6.2.1] b), [6.3.1] b)</p>				

4.4 Applicable requirements

4.4.1

The applicable requirements for each basic and additional system, component installed and procedural means adopted are given in App 2.

5 Environmental index

5.1 Index calculation

5.1.1

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.

No contribution to the ship's environmental index or to coverage of the relevant pollution sources (see [6.1] b)) will be given by the implementation of those items for which mandatory requirements are in force for the ship according to IMO Conventions due to its specific characteristics such as tonnage, navigation, etc.

Provided that the date of entry into force of IMO requirements, becoming mandatory before the delivery of the ship, is not yet known when the ship is contracted for construction, the implementation of the relevant items contributes to the ship environmental index or to coverage of the relevant pollution sources.

6 Assignment criteria

6.1 Ships other than those intended to operate at a fixed location

6.1.1

The additional class notation **GREEN PLUS** is assigned to ships not intended to operate at a fixed location:

- complying with [4.1] and [4.2]
- 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)
- having an environmental index calculated in accordance with [5.1] greater than or equal to 100.

6.2 Ships intended to operate at a fixed location

6.2.1

The additional class notation **GREEN PLUS** is assigned to a ship intended to operate at a fixed location:

- complying with [4.1] and [4.2]
- 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)
- having an environmental index calculated in accordance with [5.1] greater than or equal to 100.

6.3 Barge not provided with machinery spaces

6.3.1

The additional class notation **GREEN PLUS** is assigned to a barge not provided with machinery spaces:

- complying with [4.1] and [4.2]
- having additional systems, components and procedural means selected from items of Tab 2, pertaining to at

least five 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 40.

7 Novel features

7.1 General

7.1.1

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.

Examples are 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

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.

SECTION 2

SEA AND AIR POLLUTION PREVENTION (GREEN STAR 3 DESIGN)

1 Green Star Design

1.1 General

1.1.1 (1/7/2020)

When ships are assigned the notations **CLEAN-SEA** and **CLEAN-AIR**, the two separate notations are superseded by the cumulative additional class notation **GREEN STAR 3 DESIGN**, in accordance with Pt A, Ch 1, Sec 2, [6.8.4] c).

1.2 CLEAN SEA AND CLEAN-AIR requirements

1.2.1 CLEAN-AIR requirements (1/7/2020)

The requirements of the **CLEAN-AIR** notation may be found in Sec 3.

1.2.2 CLEAN-SEA requirements (1/7/2020)

The requirements of the **CLEAN-SEA** notation may be found in Sec 4.

SECTION 3

AIR POLLUTION PREVENTION (CLEAN-AIR)

1 General

1.1 Application

1.1.1 (1/7/2020)

This Section applies to the assignment of the notations **CLEAN-AIR**.

2 CLEAN-AIR

2.1 Application

2.1.1 Coverage (1/7/2020)

- a) The notation **CLEAN-AIR** is assigned to ships fitted with efficient means to control and prevent the emission of polluting substances in the air, in accordance with Pt A, Ch 1, Sec 2, [6.8.3].
- b) The requirements of this Section are intended to prevent air pollution from any of the following hazards in addition to those stipulated by MARPOL 73/78 Annex VI:
 - emissions of ozone depleting substances
 - emissions contributing to global warming
 - emission of nitrogen oxides (NO_x)
 - emission of sulphur oxides (SO_x)
 - incinerators

In order for the notation **CLEAN-AIR** to be granted, all the above polluting hazards are to be considered and the ship is to be fitted with means and/or operational measures to simultaneously prevent all those which are applicable, in relation to its characteristics and the likelihood of producing any or all of such emissions.

2.1.2 Additional requirements for oil tankers, chemical tankers and gas carriers

A ship which is classed with one or more of the following class notations:

- a) **oil tanker**
- b) **chemical tanker**
- c) **FLS tanker**
- d) **liquefied gas carrier**
- e) **combination carrier OOC**
- f) **combination carrier OBO**

is also to comply with the requirements of Ch 13, Sec 7 relative to the prevention of vapour emissions, excluding ships

as per a), b), c), e) and f) intended for the carriage of products having flashpoint > 60°C.

In order for the **CLEAN-AIR** notation to be granted to such a ship, it is necessary that the **VCS** notation is also granted.

2.2 Definitions

2.2.1 MARPOL 73/78

MARPOL 73/78 is the IMO "International Convention for the Prevention of Pollution from Ships, 1973/78", including the Annexes from I to VI, as amended.

2.2.2 Emission

Emission is any release to the atmosphere of substances which are covered by this Section.

2.2.3 Ozone depleting substances

Ozone depleting substances are those substances which are defined in paragraph 4 of Article 1 of the Montreal Protocol on Substances that Deplete the Ozone Layer, 1987, listed in Annexes A, B, C or E to the Protocol in force at the time of the application of these Rules.

In general, the following ozone depleting substances are used on ships; however, this list is not to be considered comprehensive of all the ozone depleting substances that for any reason may be found in a ship.

- Halon 1211 - Bromochlorodifluoromethane
- Halon 1301 - Bromotrifluoromethane
- Halon 2402
- Halon 114B2 - 1,2-Dibromo-1,1,2,2-tetrafluoroethane
- CFC-11 - Trichlorofluoromethane
- CFC-12 - Dichlorodifluoromethane
- CFC-113 - Trichloro-1,1,2,2-trifluoroethane
- CFC-114 - 1,2-Dichloro-1,1,2,2-tetrafluoroethane
- CFC-115 - Chloropentafluoroethane.

2.2.4 Shipboard incineration

Shipboard incineration is the incineration of wastes or other matter on board a ship, if such wastes or other matter are generated during the normal operation of that ship.

2.2.5 Shipboard incinerator

Shipboard incinerator is a shipboard facility designed for the primary purpose of incineration.

2.2.6 Ozone Depleting Potential

Ozone Depleting Potential (ODP) is the potential of ozone depletion compared to CFC 11. Values of ODP for ozone depleting gases are provided in the "Montreal Protocol on Substances that Deplete the Ozone Layer".

Table 1 : Documents to be submitted for prevention of emission of ozone depleting substances

No.	A/I (1)	Document
1	I	General arrangements of refrigeration plants
2	A	Scheme of refrigerating plant(s) showing the retention facilities as per [2.4.4]
3	A	Data sheets with list of intended refrigerants to be used in the different refrigeration systems and their GWP and ODP
4	I	Refrigerant record book
(1) A = to be submitted for approval in four copies; I = to be submitted for information in duplicate.		

Table 2 : Documents to be submitted for incinerators

No.	A/I (1)	Document
1	I	Copy of type approval certificate or statement of compliance with IMO Res. MEPC 76(40)
2	I	Design data, including at least design pressure and design temperature, as applicable (2)
3	A	Piping diagram (2)
4	I	System for waste supply and incinerator feeding (2)
5	A	Instrumentation, monitoring, alarm and control systems (2)
6	I	Operating manual
(1) A = to be submitted for approval in four copies; I = to be submitted for information in duplicate.		
(2) Not required if the incinerator is of an approved type.		

Table 3 : Documents to be submitted in connection with the Ship Environmental Management

No.	(1)	Document
1	I	Ship Environmental Management Plan as per [2.4.6] , [2.5.1], [2.7.2] and [2.8.1]
(1) I = to be submitted for information in duplicate.		

2.2.7 Global Warming Potential

Global Warming Potential (GWP) is the potential global warming of a gas compared with CO₂ on a time horizon of 100 years. Values of GWP for various refrigerants and gases are published by the US Environmental Protection Agency (EPA).

2.3 Documents to be submitted

2.3.1 Documents to be submitted for prevention of emission of ozone depleting substances

Tab 1 lists the documents to be submitted for the assessment of the measures taken to prevent the emission of ozone depleting substances.

The documents in Tab 1 are additional to those relative to refrigerating installations and fire-fighting systems listed in the applicable Sections of the Rules.

2.3.2 Documents to be submitted for incinerators

Tab 2 lists the documents to be submitted for incinerators.

2.3.3 Documents to be submitted in connection with the Ship Environmental Management

Tab 3 lists the documents to be submitted in connection with the Ship Environmental Management.

2.4 Emission of ozone depleting substances

2.4.1 Applicability

- The following requirements apply to ships with refrigerating facilities, such as refrigerated cargo ships, liquefied gas carriers with reliquefaction plants, and other ships with centralised cargo refrigeration systems.
- They also apply to:
 - centralised refrigeration systems for provision stores
 - centralised air conditioning plants
 - fixed fire-fighting systems.
- They do not apply to domestic type stand-alone refrigerators and air conditioning units.

2.4.2 Halogenated substances (1/7/2020)

- a) The use of ozone depleting substances (e.g. Halon and CFC) as refrigerant or fire-fighting means is prohibited.
- b) Refrigerants of centralised refrigeration systems are to have a global warming potential, GWP < 2000.

2.4.3 Prevention of leakage

- a) Means are to be provided to limit leaks to the atmosphere of refrigerants or their vapours in the event of failure of the plant, as well as in the case of discharge of refrigerant to an onshore reception facility.
- b) Annual refrigerant leakage is to be less than 10% of the total refrigerant charge of each system. 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.
- c) Procedures need to be established such that, in the event that annual leakage exceeds 10%, corrective actions are undertaken.

2.4.4 Evacuation facilities

The system is to be fitted with evacuation (e.g. compressors) and retention facilities having the capability to retain all the refrigerants, should the need to evacuate the whole plant arise in an emergency.

2.4.5 Maintenance and servicing

The plant is to be designed in such a way as to minimise the risk of medium release in the case of maintenance, repair or servicing; i.e. it is to be designed considering the possibility of isolating those sections which are to be serviced by a system of valves and bypasses, in such a way as not to stop the operation of the plant while in service, preventing the risk of release of the medium outside of the plant.

2.4.6 Procedures

The Ship Environmental Management Plan, as per [2.8.1], is to contain the following:

- procedures to be followed to minimise the risk of depleting the refrigerant or the refrigerant vapours in all operative and emergency conditions
- procedures for preparing, filing and updating the refrigerant log-book.

2.5 Emission of oxides of nitrogen (NOx)

2.5.1 Procedures (1/7/2020)

The Ship Environmental Management Plan is to contain the following:

- a) procedures for periodical checks of the emission relevant engine parameters and components referred to in the technical file. The periodical checks are to be carried out at least every 6 months and after maintenance or replacement of any such component;
- b) procedures for preparing, filling in and updating the record book of engine parameters.

2.5.2 NOx control equipment (1/7/2020)

- a) Methods to control NOx emissions

NOx emissions may be controlled by:

- engine related settings (e.g. injection advance) or arrangements (e.g. Exhaust Gas Recirculation, EGR)
- after treatment (e.g. selective catalytic reduction) or
- other methods (e.g. emulsion of water in fuel, intake air humidification, direct water or steam injection).

The relevant equipment will be subject to special consideration by the Society.

b) General requirements

- 1) Means are to be provided to check proper operation of the equipment;
- 2) Failure of the NOx emission control system and/or equipment is not to affect the normal functioning of the engine.

2.6 Emissions of sulphur oxides

2.6.1 General (1/7/2020)

The sulphur content of fuel oil used on board ships in each specific area (i.e. inside or outside ECA) is not to exceed the Sulphur content required by MARPOL 73/78 Annex VI, or the ship is to be equipped with alternative arrangements ensuring equivalent compliance as detailed in [2.6.5] and [2.6.6].

2.6.2 Ships using separate fuel oils (1/7/2020)

Ships using separate fuel oils in order to comply with [2.6.1] within Sox ECAs, are to allow sufficient time for the fuel oil service system to be fully flushed of all fuels exceeding 0,1% sulphur content prior to entry into an SOx emission control area. The volume of low sulphur fuel oils (equal to or less than 0,1% sulphur content) in each tank as well as the date, time and position of the ship when any fuel- changeover operation is completed are to be recorded in the log-book.

The change-over procedure is to be detailed in the Ship Environmental Management Plan.

2.6.3 Fuel oil management procedures (1/7/2020)

The Ship SOx Environmental Management Plan is to contain the following:

- a) Procedures to detail the maximum sulphur content in the fuel oil purchase orders and to check the actual content of sulphur at the delivery of bunker.
- b) Procedures for testing and analysis, in accordance with a recognised standard acceptable to the Society, to be used if the actual sulphur content is checked by sampling.
- c) Procedures to manage records of purchase orders, type of checking carried out and results, to be kept on board and made available to the Surveyor.
- d) Fuel management procedures to be followed as part of the vessel's certified ship management system.

2.6.4 Exhaust gas cleaning system (1/7/2020)

- a) The exhaust gas cleaning system is to have the capability to reduce the total emission of sulphur oxides from ships, including both auxiliary and main propulsion

engines, to 4,3 SO₂(ppm)/CO₂(% v/v) (Ratio emission) or less, as from MEPC.259(68).

- b) Waste streams from the use of such equipment are not to be discharged into the sea, unless compliant with the washwater discharge, monitoring and recording criteria established by MEPC.259(68).

2.6.5 Alternative methods (1/7/2020)

Any other technological method that is verifiable and enforceable to limit SO_x emissions to a level equivalent to that indicated in [2.6.1] may be considered by the Society on a case-by-case basis.

2.6.6 Documents to be submitted (1/7/2020)

Tab 4 lists the documents to be submitted for the assessment of the measures taken to prevent SO_x emission.

2.6.7 Installations to limit the emission of SO_x (1/7/2020)

If the SO_x emission is controlled by an exhaust gas cleaning system, the requirements in [2.6.8] to [2.6.10] apply.

2.6.8 Materials (1/7/2020)

Materials for piping and equipment which are part of the cleaning system are to be tested in accordance with the requirements applicable to similar types of piping or equipment and their class and/or design conditions.

2.6.9 Tests and inspection during fabrication (1/7/2020)

Piping and equipment are to be inspected and tested during fabrication in accordance with the requirements applicable to the types of piping or equipment which are part of the plant, and their class and/or design conditions.

2.6.10 Tests after installation (1/7/2020)

After installation on board, the cleaning system is to be tested in the presence of the Surveyor under operating conditions. The control, monitoring and alarm systems are also to be tested in the presence of the Surveyor or their functioning is to be simulated by a procedure agreed with the Society.

Table 4 : Documents to be submitted (1/7/2020)

No.	(1)	Document
1	A	Detailed plans of systems and equipment to limit SO _x emission in the SO _x emission control areas (2)
2	A	Ship SO _x Environmental Management Plan (3)
<p>(1) A = to be submitted for approval in four copies; I = to be submitted for information only.</p> <p>(2) Only if such systems and equipment are installed.</p> <p>(3) The Ship SO_x Environmental Management Plan is to be approved.</p>		

2.7 Incinerators

2.7.1 Applicability (1/7/2020)

- a) The following requirements apply to ships with a permanently installed shipboard incinerator, generally complying with the requirements of IMO Resolution MEPC.(76)40, as amended or MEPC.244(66) as amended, as applicable, which are contained in App 3. The content of this Appendix is to be considered as part of the requirements to be complied with in order for the **CLEAN-AIR** notation to be issued.
- b) Ships without a permanently installed incinerator, which use the main or auxiliary boilers for incinerating oil sludge generated during normal operations, cannot be granted the **CLEAN-AIR** notation.

2.7.2 Miscellaneous requirements

- a) Substances not permitted to be incinerated

Shipboard generators cannot be used to incinerate the following substances:

- cargo residues of substances indicated in Annexes I, II and III of the IMO International Convention for the Prevention of Pollution from Ships 1973/78, "MAR-

POL 73/78" as amended, and related contaminated packing materials

- polychlorinate biphenyls (PCB_n)
 - garbage, as defined in Annex V of "MARPOL 73/78", containing more than traces of heavy metals.
- b) Operating manual
A Manufacturer's operating manual for the incinerator is to be provided on board.
- c) Safety measures
- 1) The flue gas outlet temperature is to be continuously monitored.
 - 2) For incinerators fed continuously by an automatic feeding system, the waste supply is to be shut off if the temperature indicated above falls below 850 °C.
 - 3) For batch loaded incinerators, the unit is to be designed in such a way that the temperature in the combustion chamber reaches 600 °C in not less than 5 minutes.
- d) Procedures
The Ship Environmental Management Plan as per [2.8.1] is to contain the procedures needed to comply with a).

2.8 Ship Environmental Management

2.8.1 Ship Environmental Management Plan

An Environmental Management Plan, specific to the ship, is to be developed and made available on board.

The Manual is to contain at least the procedures requested in [2.4.6], [2.5.1] and [2.7.2] d) and is also to include:

- the indication of person(s) in charge for each procedure to be carried out
- documents and manuals required
- log-books/records to be filled in
- time schedule when applicable (e.g. periodical checks)

The Ship Environmental Management Plan is to be submitted to the Society for information.

2.9 Inspections and tests

2.9.1 Installations to limit the emission of refrigerants

a) Materials

Materials for piping and equipment specifically designed to limit the emission of refrigerants are to be tested in accordance with the applicable requirements for testing materials intended to be used for the con-

struction of similar types of piping and equipment and their classes and/or design conditions.

b) Tests and inspection during fabrication

Piping and equipment specifically designed to limit the emission of refrigerants are to be inspected and tested during fabrication in accordance with the requirements applicable to similar types of piping or equipment and their classes and/or design conditions.

c) Tests after installation

After installation on board, the plant acceptance trials are to include the operation of the evacuation of all of the refrigerant from the plant to the reception facilities without any release of refrigerant and/or refrigerant vapours. The control, monitoring and alarm systems are also to be tested in the presence of the Surveyor, or their functioning is to be simulated by a procedure agreed with the Society.

2.9.2 Incinerators

Unless the incinerator is of a type approved by the Society, the tests described in App 3 are to be carried out.

2.9.3 Periodical surveys

During periodical surveys, the checks and inspections requested in Pt A, Ch 5, Sec 7, as applicable, are to be carried out.

SECTION 4

SEA POLLUTION PREVENTION (CLEAN-SEA)

1 General

1.1 Application

1.1.1 Coverage

The notation **CLEAN-SEA** is assigned to ships fitted with efficient means to control and prevent the emission of polluting substances in the sea, in accordance with Pt A, Ch 1, Sec 2, [6.8.2].

The requirements of this Section are intended to prevent sea pollution from any of the following hazards:

- release of oil or oily substances into the sea
- release of noxious liquid substances into the sea
- release of harmful substances carried as cargo by sea in packaged form
- release of sewage into the sea
- release of garbage into the sea
- transfer of harmful aquatic organisms and pathogens through ballast water
- release of TBT (tributyltin) of antifouling paints
- release of grey water to sea
- ship recycling.

In order for the notation **CLEAN-SEA** to be granted, all the above hazards are to be considered within the relevant application limits. Accordingly, in relation to its characteristics and the likelihood of producing any or all of such uncontrolled release, each ship is to be fitted with means to simultaneously prevent all possible polluting hazards among those listed above.

1.2 Required certificates

1.2.1 (1/7/2020)

In order to be granted and to maintain the **CLEAN-SEA** class notation, the validity of the following Certificates is to be ensured:

- "International Oil Pollution Prevention Certificate" (IOPP Certificate), in accordance with MARPOL 73/78, Annex I.
- "International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk" (NLS Certificate) in accordance with MARPOL 73/78 Annex II, as applicable.
- "International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk" (ICOF CHE Certificate) in accordance with the IBC Code, as applicable.
- "International Sewage Pollution Prevention Certificate" (ISPP Certificate) in accordance to MARPOL 73/78, Annex IV.

- "International Antifouling System Certificate" (AFS Certificate) or statement of compliance issued in accordance with IMO Resolution MEPC.102(48) as amended.
- "International Ballast Water Management Certificate" (BWM Certificate) in accordance with BWM/CONF/36 (International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004)

Should one of the above-mentioned Certificates be suspended or not be renewed for any reason, the **CLEAN-SEA** notation will be automatically suspended until the ship is granted a new valid certificate.

1.3 Definitions

1.3.1 MARPOL 73/78

MARPOL 73/78 is the IMO "International Convention for the Prevention of Pollution from Ships, 1973/78, including the Annexes from I to VI as amended.

1.3.2 Definitions in connection with prevention of sea pollution by oil

Within these Rules all the terms used have the meaning provided in Annex I to MARPOL 73/78 as amended.

1.3.3 Definitions in connection with prevention of sea pollution by noxious liquid substances carried in bulk as cargo

Within these rules all the terms used have the meaning provided in Annex II to MARPOL 73/78 as amended.

1.3.4 Definitions in connection with prevention of sea pollution by harmful substances carried by sea in packaged form as cargo

Within these rules all the terms used have the meaning provided in Annex III to MARPOL 73/78 as amended.

1.3.5 Definitions in connection with prevention of sea pollution by sewage

Within these rules all the terms used have the meaning provided in Annex IV to MARPOL 73/78 as amended. In addition the following definitions apply:

a) Sewage

Sewage means:

- drainage and other wastes from any form of toilets and urinals,
- drainage from medical premises (dispensary, sick bay, etc.) via wash basins, wash tubs and scuppers located in such premises,
- drainage from spaces containing live animals, or
- other waste waters when mixed with the drainages defined above.

b) Treated sewage holding tank

Treated sewage holding tank means a tank used for the collection and storage of sewage downstream of the treatment plant.

c) Maximum number of persons on board.

For ro-ro passenger ships the maximum number of persons on board is the maximum number of passengers that can be accommodated in cabins plus the crew.

1.3.6 Definitions in connection with prevention of sea pollution by garbage

Within these rules all the terms used have the meaning provided in Annex V to MARPOL 73/78 as amended and in addition garbage means all kinds of victual, domestic and operational waste excluding fresh fish and parts thereof, generated during the normal operation of the ship and liable to be disposed of continuously or periodically, except those substances which are defined or listed in Annexes I, II, III and IV to MARPOL 73/78.

1.3.7 Definitions in connection with prevention of sea pollution by other sources

- a) Harmful aquatic organisms and pathogens means bacteria, plants and animals which can survive in a viable form in the ballast water and sediments carried in ships. Subsequent discharge of ballast water or sediment into the waters of port may result in threats to indigenous human, animal and plant life and the marine environment.
- b) Grey water means drainage from dishwater, shower, laundry, bath, washbasin drains and WC scuppers.
- c) Maximum number of persons on board, for the purpose of calculating grey water retention capacity for ro-ro passenger ships, means the maximum number of passengers that can be accommodated in cabins plus the crew.
- d) Antifouling system means a coating, paint, surface treatment or device that is used in a ship to control or prevent attachment of fouling organisms.
- e) TBT free antifouling means an antifouling paint in compliance with IMO Resolution MEPC.104(48), as amended.
- f) AFS Certificate means "International Antifouling System Certificate" or statement of compliance, issued in accordance with IMO Resolution MEPC.104(48), as amended.

1.3.8 Definitions in connection with the Ship Environmental Management

The Ship Environmental Manager is an officer in service on board, in charge of the management and control of the procedures and activities relevant to the requirements of this Section.

1.3.9 Definition in connection with ship recycling (1/1/2020)

The terms regarding ship recycling used in this Section have the meaning provided in IMO Resolution MEPC.269(68)

and Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009.

1.4 Documents to be submitted

1.4.1 Documents to be submitted in connection with prevention of sea pollution by oil

Tab 1 lists the documents to be submitted in connection with prevention of sea pollution by oil.

The documents listed in Tab 1 do not take account of drawings necessary for the issuance of the IOPP Certificate.

1.4.2 Documents to be submitted in connection with prevention of sea pollution by noxious substances

Tab 2 lists the documents to be submitted in connection with prevention of sea pollution by noxious substances.

The documents listed in Tab 2 do not take account of drawings necessary for the issuance of the "International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk" or of the "International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk", as applicable.

1.4.3 Documents to be submitted in connection with prevention of sea pollution by harmful substances carried by sea in packaged form

Tab 3 lists the documents to be submitted in connection with prevention of sea pollution by harmful substances carried by sea in packaged form.

1.4.4 Documents to be submitted in connection with prevention of sea pollution by sewage

Tab 4 lists the documents to be submitted in connection with prevention of sea pollution by sewage.

The documents listed in Tab 4 do not take account of drawings necessary for the issuance of the ISPP Certificate.

1.4.5 Documents to be submitted in connection with prevention of sea pollution by garbage

Tab 5 lists the documents to be submitted in connection with prevention of sea pollution by garbage.

1.4.6 Documents to be submitted in connection with prevention of sea pollution by other sources

Tab 6 lists the documents to be submitted in connection with prevention of sea pollution by other sources.

The documents listed in Tab 6 do not take account of documentation necessary for the issuance of the AFS Certificate.

1.4.7 Documents to be submitted in connection with the Ship Environmental Management

Tab 7 lists the documents to be submitted in connection with the Ship Environmental Management.

1.4.8 Documents to be submitted in connection with ship recycling (1/1/2020)

The Inventory of Hazardous Materials (IHM) is to be submitted for approval, in four copies, in connection with ship recycling.

2 Design and procedural requirements

2.1 Prevention of sea pollution by oils

2.1.1 General

Provided the ship has been granted a valid IOPP Certificate issued by an Administration or by a recognised organisation on behalf of an Administration, in accordance with MARPOL 73/78 Annex I, as applicable, the additional specific requirements as per [2.1.2] to [2.1.4] apply.

2.1.2 Tank arrangement

- a) For the purpose of these Rules, tanks for fuel oil, sludge tanks and tanks for lubricating oil, whether or not for waste, of capacity exceeding the greater of 20 m³ and V/100, where V is the total aggregate volume of such tanks, are to be considered. Overflow tanks are to be included unless they are provided with an alarm for detection of liquid and operational procedures are foreseen for keeping such tanks empty.
- b) Double bottoms for lubricating oil located under the main engine are not considered in these Rules.
- c) Such tanks, irrespective of their location, are to have the bottom at a distance h above the base line equal to or greater than B/15, 2T/11 or 2 m, whichever is the lesser, with a minimum of 0,7 m.
- d) The minimum distance w from the side and bottom shell plating, measured at any cross-section at right angles to the outer shell, is to be, in m:
- $w = 0,01 \cdot (68,69 + 0,0657 \cdot v)$
for tanks having a volume between 20 and 2000 m³
 - $w = 2$
for tanks having a volume greater than 2000 m³,
- where:
- v : Volume of the tank, in m³.
- e) Small suction wells may extend below such limit for a height lower than 350 mm or h/2, whichever is the lesser, provided that they are as small as possible.
- f) Tanks of any volume intended to contain fuel or lubricating oil are not to be used also for ballast water.
- g) All tanks and cofferdams, if any, around the tanks are to be so arranged as to be adequately inspected; such cofferdams are to be effectively protected against corrosion by means of proper protective coatings of a light colour in order to be easily examined.

Table 1 : Documents to be submitted in connection with prevention of sea pollution by oil

No.	A/I (1)	Document
1	I	Copy of the IOPP Certificate
2	A	Drawings with indication of tanks' volume and distance from the base line and shell plates as per [2.1.2] (2)
3	A	Schemes of the fuel oil, lubricating oil and relevant residue systems, containing the indications necessary to verify the requirements as per [2.1.3] (2)
4	I	Oil Systems Record Book
<p>(1) A = to be submitted for approval in four copies; I = to be submitted for information in duplicate.</p> <p>(2) If these indications are contained in the drawings and schemes used for the classification of the ship, such drawings and schemes may also be used to verify the requirements of these Rules.</p>		

Table 2 : Documents to be submitted in connection with prevention of sea pollution by noxious substances

No.	(1)	Document
1	I	Copy of the "International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk" or copy of the "International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk", as applicable
(1) I = to be submitted for information in duplicate.		

Table 3 : Documents to be submitted in connection with prevention of sea pollution by harmful substances carried by sea in packaged form

No.	(1)	Document
1	I	General arrangement plan with indication of the zone intended for the stowage of the harmful packaged substances in relation to the other zones of the ship
2	I	Plans of systems and equipment to discharge the harmful substances in case of emergency and to dispose of and wash possible leaks
(1) I = to be submitted for information in duplicate.		

Table 4 : Documents to be submitted in connection with prevention of sea pollution by sewage (1/7/2020)

No.	A/I (1)	Document
1	I	General arrangement plan with indication of the sewage treatment plant enclosing details on treatment procedures (2)
2	I	Copy of the ISPP Certificate and type approval certificate for the sewage treatment plant according to MEPC.2(VI), or MEPC.159(55), or MEPC.227(64) as amended, as applicable
3	A	Calculation of volume of holding tank(s) for treated sewage
4	I	General information on control and monitoring systems (2)
5	I	Sewage record book
(1) A = to be submitted for approval in four copies; I = to be submitted for information in duplicate.		
(2) Not required if the sewage treatment plant is of an approved type.		

Table 5 : Documents to be submitted in connection with prevention of sea pollution by garbage

No.	A/I (1)	Document
1	I	General information on garbage treatment equipment (2) (3)
2	A	Garbage management plan including garbage record book as specified by MARPOL 73/78 Appendix to Annex V
3	I	General description of control and monitoring systems of garbage treatment equipment (2)
(1) A = to be submitted for approval in four copies; I = to be submitted for information in duplicate.		
(2) Not required if the garbage treatment equipment is of an approved type.		
(3) For incinerators see Sec 3.		

Table 6 : Documents to be submitted in connection with prevention of sea pollution by other sources (1/7/2020)

No.	A/I (1)	Document
1	A	Ballast water management plan, including a ballast water record book, developed in accordance with IMO Res. A.868(20)
2	I	Copy of the AFS Certificate and details of TBT free antifouling paint
3	A	Calculation of volume of grey water holding tank(s) (passenger ships only)
4	I	Grey water record book (passenger ships only)
5	I	Copy of the BWM Certificate
(1) A = to be submitted for approval in four copies; I = to be submitted for information in duplicate.		

Table 7 : Documents to be submitted in connection with the Ship Environmental Management (1/1/2020)

No.	A/I (1)	Document
1	I	Ship Environmental Management Plan as per [2.1.4], [2.3.6], [2.4.4], [2.5.4], [2.6.4] and [2.8.2]
2	A	Inventory of Hazardous Materials (IHM) as per [2.7.4]
(1) A = to be submitted for approval in four copies; I = to be submitted for information in duplicate.		

2.1.3 Systems

- a) All fuel oil and lubricating oil tanks of capacity greater than 10 m³ 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 station from which bunkering or transfer operations are controlled.
- c) On the weather and/or superstructure decks each fuel or lubricating oil tank vent, overflows 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.
- d) The oil filtering equipment, requested by MARPOL Annex I, is to be provided with an oil content meter and with a 15 ppm alarm combined with automatic stopping device.
- e) The effluent from the 15 ppm filtering equipment is to be capable of being recirculated to a bilge water holding tank. Such tank is to be so arranged as to allow periodical removal of sediments.
- f) A holding tank is to be fitted for the pre-separation of bilge water before conveying it to the separating or filtering equipment.
- g) The volume V of such a tank, in m³, is to be at least:
- $$V = 1 + 5,5P \cdot 10^{-4}$$
- 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 m³.
- Particular cases, for instance with regard to the service, range and installed power, will be specially considered.
- h) For ships operating with fuel oil having a mass density at 15°C greater than 0,94 kg/dm³ and viscosity at 50°C greater than 110 centistokes, the possibility of heating such a tank is to be provided.
- i) Ships operating with heavy fuel oil are to be provided with tanks for sludge from the fuel oil purifiers without internal structures and with a suitable heating system.
- j) The sludge tank is to be so arranged as to allow periodical removal of sediments. Sludge is either to be disposed of on board through the incinerator or discharged ashore and is to be recorded in the oil record book.
- Use of boilers for sludge disposal on board is not allowed unless a treatment system or special device is installed to improve emissions generated by sludge incineration, subject to Tasneef's approval.

2.1.4 Procedures

- a) 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, stern tubes, 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 sealing.

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.

- b) The Ship Environmental Management Plan referred to in [2.8.2] is to include procedures covering the following:
- oily waste management including discharge criteria;
 - preparation, filling in and maintenance of the oil record book and of the "Systems oil consumption log-book";
 - periodical calibration of the oil content meter referred to in [2.1.3], to be carried out 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 bilge holding tank and of the sludge tank
 - spillage during bunkering;
 - periodical checks of the overflow systems/alarms.

2.2 Prevention of sea pollution by noxious liquid substances carried in bulk as cargo

2.2.1 Application

The following requirements apply to all ships.

2.2.2 General

Provided the ship has been granted a valid "NLS" or a valid "ICOF CHE" certificate, as applicable, issued by an Administration or by a recognised organisation on behalf of an Administration, in accordance with MARPOL 73/78 Annex II, as applicable, there are no additional specific requirements to be complied with on this matter for the purpose of the issuance of the CLEAN-SEA notation.

2.3 Prevention of sea pollution by harmful substances carried by sea as cargo in packaged form

2.3.1 General

Harmful substances carried as cargo in packaged form are to be properly stowed and secured so as to minimise the hazards to the marine environment, according to MARPOL 73/78 Annex III, as amended.

2.3.2 Stowage

- a) Harmful substances are to be properly stowed and secured so as to minimise the hazards to the marine environment without impairing the safety of the ship and persons on board.

- b) Certain harmful substances may, for sound scientific and technical reasons, need to be prohibited for carriage or be limited as to the quantity which may be carried aboard any one ship. In limiting the quantity, due consideration is to be given to the size, construction and equipment of the ship, as well as the packaging and the inherent nature of the substances.
- c) Each ship carrying harmful substances is to have a special list or manifest setting forth the harmful substances on board and the location thereof. A detailed stowage plan which sets out the location of the harmful substances on board may be used in place of such special list or manifest.

2.3.3 Empty packages

Empty packages which have been used previously for the carriage of harmful substances are themselves to be treated as harmful substances, unless adequate precautions have been taken to ensure that they contain no residue that is harmful to the marine environment.

2.3.4 Marking

- a) Packages containing a harmful substance are to be durably marked with the correct technical name (trade names alone are not to be used) and, additionally, are to be durably marked or labelled to indicate that the substance is a marine pollutant. Such identification is to be supplemented where possible by other means, for example, by use of the relevant United Nations number.
- b) The method of marking the correct technical name and of affixing labels on packages containing a harmful substance is to be such that this information will still be identifiable on packages surviving at least three months' immersion in the sea. In considering suitable marking and labelling, account is to be taken of the durability of the materials used and of the surface of the package.
- c) Packages containing small quantities of harmful substances may be exempted from the marking requirements.

2.3.5 Leaks

- a) Jettisoning of harmful substances carried in packaged form is not permitted, except where necessary for the purpose of securing the safety of the ship or saving life at sea.
- b) Appropriate measures based on the physical, chemical and biological properties of harmful substances are to be taken to regulate the washing of leakages overboard, provided that compliance with such measures would not impair the safety of the ship and persons on board.

2.3.6 Procedures

The Ship Environmental Management Plan referred to in [2.8.2] is to include procedures covering the requirements of this item [2.3].

2.4 Prevention of sea pollution by sewage

2.4.1 General

Provided the ship has been granted a valid ISPP Certificate issued by an Administration or by a recognised organisation

on behalf of an Administration, in accordance with MARPOL 73/78 Annex IV, as applicable, the additional specific requirements as per [2.4.2] to [2.4.4] apply.

2.4.2 Discharge of sewage at sea

All sewage discharges whether to sea or shore based facilities are to be recorded in the sewage record book with indication of the date, location and quantity of sewage discharged and are to comply with MARPOL Annex IV discharge requirements.

2.4.3 Sewage treatment plant (1/7/2020)

- a) A sewage treatment plant, meeting operational requirements based on the standards and test methods as detailed in Resolution MEPC.2(VI), or MEPC.159(55), or MEPC.227(64) as amended, as applicable, is to be installed on board.
- b) 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 minimum total capacity of such tank(s) is to be 2 days based on the maximum number of persons on board and 96 litres/person/day if a conventional (flushometer) system is used and 11 litres/person/day if a vacuum system is used.

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 post-treatment system for sewage, able to reduce the volume of the effluent (ex. by recycling part of the treated sewage water for on board use);
 - 2 days retention is ensured;
 - technical documentation, including results of on-board tests, of the system's efficiency and of effluent volume reduction is documented to the satisfaction of the Society.
- c) The ship is to be equipped with a pipe leading to the exterior convenient for the discharge of sewage to a reception facility; such pipe is to be fitted with a standard shore connection in compliance with MARPOL Annex IV, and the materials, piping, fittings and equipment are to comply with the applicable requirements of the various Sections of these Rules.
- d) Treated sewage holding tanks are to be equipped with high level alarms.

2.4.4 Procedures

The Ship Environmental Management Plan referred to in [2.8.2] is to include procedures covering the following:

- 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 of ashore or by incineration.

2.5 Prevention of sea pollution by garbage

2.5.1 General

The applicable requirements of MARPOL 73/78 Annex V, as amended, are to be complied with, in addition to the following additional specific requirements.

2.5.2 Placards, garbage management plans and garbage record-keeping

- a) Placards which notify the crew and passengers of the disposal requirements of MARPOL Annex V are to be fitted on board as applicable.
- b) The placards are to be written in the official language of the State whose flag the ship is entitled to fly and, for ships engaged in voyages to ports or offshore terminals under the jurisdiction of other States, in English or French.
- c) A garbage management plan and record book is to be available on board. This plan is to provide written procedures for collecting, storing, processing and disposing of garbage, including the use of the equipment on board. It is also to designate the person in charge of carrying out the plan. Such plan is to be in accordance with the guidelines in IMO Resolution MEPC.220(63) and written in the working language of the crew.
- d) For passenger ships, special consideration in the garbage management plan is to be given to the following potentially hazardous wastes:
 - Photographic and x-ray development fluids
 - Dry-cleaning solvents and waste fluids
 - Print shop fluids
 - Photocopying and laser printer cartridges
 - Unused pharmaceuticals and those which are past their use-by date
 - Batteries
 - Fluorescent and Mercury vapor lamp bulbs.

2.5.3 Waste recycling

For passenger ships other than ro-ro passenger ships:

- a) a strategy of waste recycling is to be foreseen, adopted and documented;
- b) the minimum total quantity of wastes landed for recycling (W_r) is to be 50% of recyclable wastes produced on board (W_b), where $W_b = 40 \text{ Kg/person/year}$ based on the number of persons the ship is certified to carry.

The amount of waste landed for recycling is to be recorded in the garbage record book, and different wastes are to be collected and landed separately.

For the purpose of this Rule, recyclable wastes are:

- Plastic
- Aluminum
- Glass
- Paper-Cardboard.

2.5.4 Procedures

The Ship Environmental Management Plan referred to in [2.8.2] is to include procedures covering the Garbage management and waste recycling, according to this item [2.5].

2.6 Prevention of sea pollution by other sources

2.6.1 Transfer of harmful aquatic organisms and pathogens through ballast water (1/7/2020)

The applicable requirements of the "IMO International Convention for the control and management of ship's ballast water and sediments, 2004" are to be complied with.

A ballast water management plan, including a ballast water record book, is to be developed and used for ballast water management.

2.6.2 Antifouling system

- a) Antifouling systems for the hull are to be of TBT-free type.
- b) The AFS Certificate and documentation of the TBT-free antifouling system are to be kept on board for checking during periodical surveys.

2.6.3 Release of grey water

The requirements of this item apply only to passenger and ro-ro passenger ships

- a) Ships are 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 and 200 litres/person/day.
- b) Grey water holding tanks are to be equipped with high level alarms.
- c) 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 [2.4.3] 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 recycling part of the treated greywater for on board use);

- 2 days retention is ensured;
 - technical documentation, including results of on-board tests, of the system's efficiency and of effluent volume reduction is documented to the satisfaction of the Society.
- d) 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.
- e) 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.
- f) All grey water discharges whether to sea or shore-based facilities are to be recorded in the grey water record book with indication of the date, location and quantity of grey water discharged. If the grey water is discharged to sea, the records are to include information on distance to the nearest land.

2.6.4 Procedures

The Ship Environmental Management Plan referred to in [2.8.2] is to include procedures requested in [2.6] including the grey water discharge criteria and use of holding tanks in ports and in no discharge areas.

2.7 Ship recycling

2.7.1 General

Some of the problems associated with ship recycling might be addressed at the design and construction stage, not only in relation to the ships themselves but also in respect of ships equipment.

The first step is to identify any potentially hazardous materials which might be incorporated, as a matter of routine, in the structure of ships and their equipment and, where practicable, consider using less hazardous alternatives.

2.7.2 Initial stage

The initial stages might include an evaluation of:

- a) the type, amount and potential hazard of materials utilised and their location on board a ship;
- b) the activities expected during the operation of the ship and any potentially hazardous wastes which might be generated; and
- c) the feasibility of addressing the potential for hazardous waste generation by considering:
- 1) product reformulation - installing components utilising less potentially hazardous materials;
 - 2) cleaner production technologies - which generate less waste;
 - 3) process modification - to generate less waste;
 - 4) input substitution - utilising less potentially hazardous consumables or those which generate less waste; and
 - 5) on-site, closed-loop recycling - systems that recycle wastes on board the ship.

2.7.3 Design stage

When designing and constructing a vessel, due account is to be taken of the ship's ultimate disposal, by:

- a) using materials which can be recycled safely and in an environmentally sound manner; and
- b) minimising the use of materials known to be potentially hazardous to health and the environment.

2.7.4 Ship Recycling (1/1/2020)

The Inventory of Hazardous Materials (IHM) is to be developed according to IMO Resolution MEPC.269(68) "2015 Guidelines for the development of the inventory of hazardous materials".

In application of the requirements of the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009, the Inventory of Hazardous Materials (IHM) provides detailed information with regard to potentially hazardous materials utilised in the construction of the ship, its equipment and systems.

This document accompanies the ship throughout its operating life and incorporates all relevant design and equipment changes, with the final Owner delivering the document, with the ship, to the recycling facility.

2.8 Ship Environmental Management

2.8.1 Ship Environmental Manager

A Ship Environmental Manager, as defined in [1.3.8], is to be available on board.

2.8.2 Ship Environmental Management Plan

An Environmental Management Plan, specific to the ship, is to be developed and made available on board.

The Manual is to contain at least the procedures requested in [2.1.4], [2.3.6], [2.4.4], [2.5.4] and [2.6.4], and is to include:

- the indication of person(s) in charge for each procedure to be carried out
- documents and manuals required
- log-books/records to be filled in
- time schedule when applicable (e.g. checking, sampling, etc.)

The Ship Environmental Management Plan is to be submitted to the Society for information.

3 Inspections and tests

3.1 Inspections and testing during construction

3.1.1 Materials

Materials for piping and equipment which are used for the construction of equipment and systems to be installed on board in connection with the requirements of this Section are to be tested in accordance with the Sections of the Rules applicable to similar types of piping or equipment and their class and/or design conditions.

3.1.2 Tests and inspection during fabrication

Piping and equipment relative to the means for preventing sea pollution, as stated in this Section, are to be inspected and tested during fabrication in accordance with the Sections of the Rules applicable to the type of piping or equipment and the relevant class and/or design conditions.

3.2 Inspection and testing after installation on board

3.2.1

After installation on board, the equipment and systems installed in connection with the requirements of this Section

are to be tested in the presence of the Surveyor under operating conditions. The control, monitoring and alarm systems are also to be tested in the presence of the Surveyor or their functioning is to be simulated by a procedure agreed with the Society.

3.3 Periodical surveys

3.3.1

During periodical surveys, the checks and inspections requested in Pt A, Ch 5, Sec 7, as applicable, are to be carried out.

SECTION 5

SEA AND AIR POLLUTION PREVENTION (GREEN STAR 3)

1 Green Star 3

1.1 General

1.1.1 Application (1/7/2020)

The additional class notation **GREEN STAR 3** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.8.4] d), to ships fitted with efficient means to control and prevent the emission of polluting substances in the sea and in the air, in accordance with the requirements of this item.

1.1.2 Required certificates (1/7/2020)

In order to be granted and to maintain the **GREEN STAR 3** class notation, the validity of the following documents is to be ensured:

- "International Oil Pollution Prevention Certificate" (IOPP Certificate), in accordance with MARPOL 73/78, Annex I.
- Approved Shipboard Oil Pollution Emergency Plan (SOPE Plan).
- "International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk" (NLS Certificate) in accordance with MARPOL 73/78 Annex II, as applicable.
- "International Certificate of Fitness for the Carriage of Dangerous Chemicals in Bulk" (ICOF CHE Certificate) in accordance with the IBC Code, as applicable.
- "International Sewage Pollution Prevention Certificate" (ISPP Certificate) in accordance with MARPOL 73/78, Annex IV.
- "International Anti-fouling System Certificate" (AFS Certificate) or statement of compliance, issued in accordance with IMO Resolution MEPC.102(48) as amended.
- Oil filtering equipment type approval certificate, in accordance with IMO Resolution MEPC.60(33) as amended or MEPC.107(49) as amended, as applicable.
- Sewage treatment plant type approval certificate in accordance with IMO Resolution MEPC.2(VI) as amended.
- Incinerator type approval certificate in accordance with IMO resolution MEPC.59(33) as amended or MEPC.76(40) as amended, as applicable.
- "Engine International Air Pollution Prevention Certificate" (EIAPP Certificate or Document of Compliance), in accordance with NOx technical code defined in [1.1.3], l).
- "International Ballast Water Management Certificate" (BWM Certificate) in accordance with BWM/CONF/36

(International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004).

Should one of the above-mentioned Certificates be suspended or not be renewed for any reason, the **GREEN STAR 3** notation will be automatically suspended until the ship is granted a new valid certificate.

1.1.3 Definitions (1/7/2020)

a) Sewage

Sewage means:

- drainage and other wastes from any form of toilet and urinal;
- drainage from medical premises (dispensary, sick bay, etc.) via wash basins, wash tubs and scuppers located in such premises;
- drainage from spaces containing live animals; or
- other waste waters when mixed with the drainages defined above.

b) Treated sewage holding tank

Treated sewage holding tank means a tank used for the collection and storage of the effluent of the sewage treatment plant.

c) Garbage

Garbage means all kinds of victual, domestic and operational waste excluding fresh fish and parts thereof, generated during the normal operation of the ship and liable to be disposed of continuously or periodically, except those substances which are defined or listed in Annexes I, II, III and IV to MARPOL 73/78.

d) Harmful aquatic organisms and pathogens

Harmful aquatic organisms and pathogens means bacteria, plants and animals which can survive in a viable form in the ballast water and sediments carried in ships.

e) Grey water

Grey water means drainage from dishwasher, galley, shower, laundry, bath, washbasin drains and WC scuppers.

f) TBT free antifouling system

Antifouling system means a coating, paint, surface treatment or device used to control or prevent attachment of organisms.

TBT free antifouling system means an antifouling system in compliance with the IMO Resolution MEPC.102(48) as amended.

g) Oily wastes

Oily wastes means the water removed from the machinery space bilges, used lube and hydraulic oils, sludge from fuel oil and from lube oil treatment systems.

- h) Harmful substances carried in packaged form
- Harmful substances are those substances which are identified as marine pollutants in the International Maritime Dangerous Goods Code (IMDG Code) as amended.
 - Packaged form is the form of containment specified for harmful substances in the IMDG Code.

i) Ozone depleting substances

Ozone depleting substances are those substances which are defined in paragraph 4 of Article 1 of the Montreal Protocol on Substances that Deplete the Ozone Layer, 1987, listed in Annexes A, B, C or E to the Protocol in force at the time of the application of these Rules.

In general, the following ozone depleting substances are used on ships; however, this list is not to be considered comprehensive of all the ozone depleting substances that for any reason may be found in a ship.

- Halon 1211 - Bromochlorodifluoromethane
- Halon 1301 - Bromotrifluoromethane
- Halon 2402
- Halon 114B2 - 1,2-Dibromo-1,1,2,2- tetrafluoroethane
- CFC-11 - Trichlorofluoromethane
- CFC-12 - Dichlorodifluoromethane
- CFC-113 - Trichloro-1,2,2-trifluoroethane
- CFC-114 - 1,2-Dichloro-1,1,2,2- tetrafluoroethane
- CFC-115 - Chloropentafluoroethane.

j) SOx emission control area

SOx emission control area is an area where the adoption of special mandatory measures for SOx emissions from ships is required to prevent, reduce and control air pollution from SOx and its attendant adverse impacts on land and sea areas. SOx emission control areas are listed in Regulation 14 of Annex VI to MARPOL 73/78 as amended.

k) Global Warming Potential

Global Warming Potential (GWP) is the potential global warming of a gas compared with CO₂ on a time horizon of 100 years. Values of GWP for various refrigerants and gases are published by the US Environmental Protection Agency (EPA); if more than one value is listed, the lowest is to be used for the purpose of compliance with these Rules.

l) NOx technical code

NOx technical code is the Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines adopted by IMO Conference MP/CONF.3/35 - Resolution 2, as amended.

m) Engine major conversion

For the purpose of these Rules, major conversion means:

- the engine is replaced by a new engine built on or after 1 January 2000; or
- any substantial modification, as defined in the NOx technical code, is made to the engine; or
- the maximum continuous rating of the engine is increased by more than 10%.

n) Ship Environmental Manager

The Ship Environmental Manager is an officer in service on board, in charge of the management and control of the procedures and activities relevant to the requirements of this section.

- o) Maximum number of persons on board, for the purpose of calculating grey water and sewage retention capacity for ro-ro passenger ships, means the maximum number of passengers that can be accommodated in cabins plus the crew.

1.1.4 Documents to be submitted

a) Plans and documents

Tab 1 lists the plans and documents to be submitted.

b) Operational procedures and log-books

Tab 2 lists the procedures and record books to be submitted.

1.2 Prevention of sea pollution

1.2.1 Oily wastes

a) Compliance with MARPOL 73/78 Annex I

The applicable requirements of MARPOL 73/78 Annex I, as amended, are to be complied with in addition to those in b) to e) and [1.2.2].

b) Bilge water

- 1) All machinery spaces 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 m³, 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 m³.

Taking into account the ship service, navigation and installed power, a smaller volume V may be accepted on a case-by-case basis.

- 2) The oil filtering equipment is to be provided with an oil content meter and with a 15 ppm alarm combined with automatic stopping device.
- 3) The effluent from the 15 ppm filtering equipment is to be capable of being recirculated to the bilge or bilge water holding tank.
- 4) The tank is to be so arranged as to allow periodical removal of sediments.

c) Sludge

The sludge tank is to be so arranged as to allow periodical removal of sediments.

Sludge is to be disposed of on board through the incinerator or discharged ashore and is to be recorded in the oil record book.

Use of boilers for sludge disposal on board is not allowed.

d) Use of oil tanks for ballast

Irrespective of their volume, tanks intended for fuel or lubricating oil cannot be used for ballast.

e) Procedures and checks

The Ship Environmental Management Plan referred to in [1.4.2] is to include procedures covering the following:

- oily waste management including discharge criteria;
- preparation, filling in and maintenance of the oil record book;
- periodical calibration of the oil content meter referred to in b), to be carried out 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;
- periodic cleaning of the bilge holding tank and of the sludge tank.

Table 1 : Documents to be submitted (1/7/2020)

No.	A/I	Document
1	I	Copy of the NLS or ICOF Certificate, if applicable
2	I	Copy of the IOPP Certificate
3	A	Drawings of the bilge system including volume of the bilge holding tank (4)
4	I	Copy of the type approval certificate of the oil filtering equipment and alarm
5	A	Schemes of the fuel oil, lubricating oil and relevant overflow system containing the information necessary to verify the requirements of [1.2.2], b) (4)
6	I	Copy of the approved SOPE Plan including the list of emergency equipment
7	I	Details of enrolment in an Emergency Response Service according to [1.2.2], a)
8	I	Copy of the ISPP Certificate and copy of the sewage treatment plant type approval certificate
9	A	Drawings of the sewage system including piping, holding tank for treated sewage and alarms (4)
10	A	Calculation of volume of holding tank for treated sewage (4)
11	I	Copy of the AFS Certificate or statement of compliance
12	A	Drawings of the greywater system including piping, holding tank and alarms (1) (4)
13	A	Calculation of volume of grey water holding tank (1) (4)
14	A	Data sheets with the list of refrigerants and fixed fire-fighting means used, their quantity and GWP values (4)
15	A	Details of plans of systems and equipment to limit SOx emissions in SOx emission control areas (2) (4)
16	A	Drawings of fuel oil system, arrangements and procedures for use of separate fuel oil according to (4)
17	I	Incinerator type approval certificate (2)
18	I	Documentation of compliance with technical requirements for the class notation VCS (3)
19	I	Copy of the EIAPP Certificate or statement of compliance for each engine detailed in [1.3.2] a), 2) issued by a recognized organization, as applicable
20	A	Engine Technical File and record book [1.3.2] d) for each engine detailed in [1.3.2] a), 2)
21	A	Details and operating manual(s) of NOx control equipment referred to in [1.3.2] e) (2)
22	I	General arrangement plan with indication of the zone intended for the stowage of the harmful packaged substances in relation to the other zones of the ship
<p>(1) Passenger ships only (2) Only if such a system is installed on board (3) Only ships having service notation according to (4) For ships in service, alternative documentation may be accepted provided it is sufficient for the execution of the initial survey Note 1: A - to be submitted for approval in four copies I - to be submitted for information in duplicate</p>		

No.	A/I	Document
23	I	Plans of systems and equipment to discharge the harmful substances in case of emergency and to dispose of and wash possible leaks
24	I	Copy of the BWM Certificate
<p>(1) Passenger ships only (2) Only if such a system is installed on board (3) Only ships having service notation according to (4) For ships in service, alternative documentation may be accepted provided it is sufficient for the execution of the initial survey</p> <p>Note 1: A - to be submitted for approval in four copies I - to be submitted for information in duplicate</p>		

Table 2 : Operational procedures and record books (1/7/2020)

No.	A/I	Document
1	I	Oil Systems Record Book
2	I	Sewage record book
3	A	Garbage management plan including garbage record book
4	A	Ballast water management plan including ballast water record book
5	I	Grey water record book (2)
6	I	Refrigerant log book and procedures [1.3.1]
7	I	Oily wastes management procedures according to [1.2.1], e)
8	I	Accidental oil discharge management procedures according to [1.2.2], c)
9	I	Sewage management procedures according to [1.2.3], d)
10	I	Garbage management and waste recycling procedures according to [1.2.4] (1)
11	I	Grey water management procedures according to [1.2.5] (2)
12	I	Ship Environmental Management Plan
13	I	Fuel management procedures for controlling SOx
14	I	Incinerator management procedures according to [1.3.4]
15	A	Inventory of Hazardous Materials (IHM) according to [1.3.5]
<p>(1) Only for passenger ships other than ro-ro passenger ships (2) Only for passenger ships and ro-ro passenger ships</p> <p>Note 1: A - to be submitted for approval in four copies I - to be submitted for information in 2 copies</p>		

1.2.2 Accidental oil discharge

a) Emergency response

- 1) The ship is to be enrolled in Society's Emergency Response Service.
- 2) A Shipboard Oil Pollution Emergency Plan (SOPE Plan) is to be available on board in accordance with Regulation 26 of MARPOL 73/78 Annex I.

b) Accidental spillage of oils

- 1) All fuel oil and lubricating oil tanks of capacity greater than 10m³ are to be fitted with:
 - an overflow system and a high level alarm or
 - an overflow system and flow alarm in the overflow main or
 - two high level alarms (90% and 95% of filling).

The alarm signals are to be given in a suitable station from which bunkering or transfer operations are controlled.

- 2) On the weather and/or superstructure decks each fuel or lubricating oil tank vent, overflows 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.
- 3) Emergency equipment (e.g. containment boom) is to be available on board and listed in the SOPE Plan. On board procedures and training are to be foreseen for the use of such equipment.

- 4) 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, stern-tubes, bow and stern thruster, 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 sealing.

The record 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.

c) Procedures and checks

The Ship Environmental Management Plan referred to in [1.4.2] is to include procedures for the management of:

- spillage during bunkering;
- collision or grounding involving oil spillage and including use of emergency equipment referred to in b);
- preparation, filling in and maintenance of the oil record book and of the "Systems oil consumption log-book";
- periodical checks of the overflow systems/alarms.

1.2.3 Sewage (1/7/2020)

a) Compliance with MARPOL 73/78 Annex IV

The applicable requirements of MARPOL 73/78 Annex V, as amended, are to be complied with, in addition to the requirements in b) to d).

b) Sewage treatment plant

- 1) The ship is to be provided with a sewage treatment plant certified according to the standards and test methods of MEPC.2(VI) or MEPC.159(55), or MEPC.227(64) as amended, as applicable.
- 2) In addition, the ship is to be equipped with holding tank(s) for sewage with sufficient capacity to allow storage of sewage when in port or in no discharge areas.

The minimum total capacity of such tank(s) is to be 2 days based on the maximum number of persons on board and 96 litres/person/day if a conventional (flushometer) system is used and 11 litres/person/day if a vacuum system is used.

A smaller volume, though in any case not lower than 50% of the above capacity, may be accepted provided that:

- the ship is equipped with a post-treatment system for sewage, able to reduce the volume of the effluent (e.g. by recycling part of the treated sewage water for on board use);
- 2 days' retention is ensured;
- technical documentation, including results of on-board tests, of the system's efficiency and of effluent volume reduction, is documented to the satisfaction of the Society.

- 3) Sewage holding tanks are to be equipped with high level alarms.

c) Sewage Record Book

All sewage discharges whether to sea or shore based facilities are to be recorded in a sewage record book with indication of the date, location and quantity of sewage discharged.

If the sewage is discharged to sea, the records are to include information on the ship speed and distance to the nearest land.

d) Procedures and checks

The Ship Environmental Management Plan referred to in [1.4.2] is to include procedures covering the following:

- 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 of ashore or by incineration.

1.2.4 Garbage (1/7/2020)

a) Compliance with MARPOL 73/78 Annex V

The applicable requirements of MARPOL 73/78 Annex V, as amended, are to be complied with, in addition to those in b) to d).

b) Garbage management plan and garbage record book

- 1) The ship is to be provided with an approved garbage management plan to be kept on board. This plan is to provide written procedures for collecting, storing, processing and disposing of garbage, including the use of the equipment on board. It is also to designate the person in charge of carrying out the plan.

The plan is to be in accordance with the guidelines in IMO Resolution MEPC. 220(63) and written in the working language of the crew.

- 2) For passenger ships, procedures are to be foreseen for the collection and safe disposal ashore of the following hazardous wastes:
 - Photographic and x-ray development fluids
 - Dry-cleaning solvents and waste fluids
 - Print shop fluids
 - Photocopying and laser printer cartridges
 - Unused pharmaceuticals and those which are past their use-by date
 - Batteries
 - Fluorescent and Mercury vapor lamp bulbs.

- 3) Records of discharges are to be maintained in the garbage record book.

c) Waste recycling

For passenger ships other than ro-ro passenger ships:

- 1) a strategy of waste recycling is to be foreseen, adopted and documented;
- 2) the minimum total quantity of wastes landed for recycling (Wr) is to be 50% of recyclable wastes produced on board (Wb), where $Wb = 40 \text{ Kg/per-}$

son/year based on the number of persons the ship is certified to carry.

The amount of waste landed for recycling is to be recorded in the garbage record book, and different wastes are to be collected and landed separately.

For the purpose of this Rule, recyclable wastes are:

- Plastic
- Aluminum
- Glass
- Paper-Cardboard

d) Procedures

The Ship Environmental Management Plan referred to [1.4.2] is to include procedures covering the following:

- Garbage management according to b)
- waste recycling according to c).

1.2.5 Other sources (1/7/2020)

a) Transfer of harmful aquatic organisms and pathogens through ballast water

The applicable requirements of the "IMO International Convention for the control and management of ship's ballast water and sediments, 2004" are to be complied with.

A ballast water management plan, including a ballast water record book, is to be developed and used for ballast water management.

b) Antifouling system

Antifouling systems for the hull are to be of TBT-free type, according to IMO Resolution MEPC.102(48), as amended.

Antifouling systems applied on existing ships and not in compliance with the appendix of IMO Res./MEPC.102(48) are to be removed or sealed the next time the ship is in dry dock.

c) Grey water

Grey water requirements in this item c) and in items d) and e) apply only to passenger and ro-ro passenger ships, except 4) which applies to all ships.

1) 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.

2) Passenger ships and ro-ro passenger ships are 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 1 day. The total capacity of grey water holding tank(s) is to be based on the maximum number of persons on board and 200 litres/person/day.

3) Grey water holding tanks are to be equipped with high level alarms.

4) If the same tanks are used to hold treated sewage and grey water:

- the capacity of such tanks is to be at least the sum of the capacities for the treated sewage holding tank in [1.2.3] b) and the tank for grey water, and the sewage treatment and discharge criteria apply.

d) Grey water record book

All grey water discharges whether to sea or shore based facilities are to be recorded in a grey water record book with indication of the date, location and quantity of grey water discharged.

If the grey water is discharged to sea, the records are to include information on distance to the nearest land.

e) Procedures and checks

In addition to the requirements in item d), the Ship Environmental Management Plan referred to [1.4.2] is to include procedures covering grey water discharge criteria, including use of holding tanks in ports and in no discharge areas.

f) Harmful substances carried in packaged form

Harmful substances are to be properly stowed and secured so as to minimise the hazards to the marine environment, according to MARPOL 73/78 Annex III, as amended.

g) Ship recycling

The Inventory of Hazardous Materials (IHM) is to be developed according to IMO Resolution MEPC.269(68) "2015 Guidelines for the development of the inventory of hazardous materials".

In application of the requirements of the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009, the Inventory of Hazardous Materials (IHM) provides detailed information with regard to potentially hazardous materials utilised in the construction of the ship, its equipment and systems.

This document accompanies the ship throughout its operating life and incorporates all relevant design and equipment changes, with the final Owner delivering the document, with the ship, to the recycling facility.

1.3 Prevention of air pollution

1.3.1 Ozone depleting substances (1/7/2020)

a) General

1) The following requirements apply to ships with refrigerating facilities, such as refrigerated cargo ships, liquefied gas carriers with reliquefaction plants, and other ships with centralised cargo refrigeration systems.

2) They also apply to:

- centralised refrigeration systems for provision stores;
- centralised air conditioning plants;
- fixed fire-fighting systems.

3) They do not apply to domestic type stand-alone refrigerators and air conditioning units.

b) Ozone depleting substances

- 1) The use of halogenated substances (e.g. Halon and CFC) as refrigerant or fire-fighting means is prohibited, with the exception of hydro-chlorofluorocarbons (HCFC_n), which are permitted until 1 January 2020.
- 2) Refrigerants of centralised refrigeration systems are to have a global warming potential, GWP < 2000. When this is not possible due to assessed technical reasons (documented in a technical report), 2000 < GWP < 4000 is accepted in accordance with c).

c) Control of leakage

- 1) Annual refrigerant leakage is to be less than 10% of the total refrigerant charge of each system. When $2000 \leq GWP < 4000$, the refrigerant leakage is to be less than

$$10 \cdot \frac{2000}{GWP}$$

% of the total refrigerant charge of each system.

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.

- 2) Procedures need to be established such that, in the event that the annual leakage exceeds the maximum allowed, corrective actions are undertaken.

d) Procedures and checks

The Ship Environmental Management Plan referred to [1.4.2] is to include procedures covering the following:

- 1) refrigerant management including control of leakage and preparation, filling in and maintenance of the refrigerant log-book according to c);
- 2) minimisation of the risk of depleting the refrigerant in the various operating conditions including during maintenance.

1.3.2 Emissions of nitrogen oxides (NOx) (1/7/2020)

a) Procedures and checks

The Ship Environmental Management Plan referred to [1.4.2] is to include procedures covering the following:

- 1) periodical checks of the emission relevant engine parameters and components referred to in d), at least every 6 months and after maintenance or replacement of any such component;
- 2) preparation, filling in and updating of the record book of engine parameters.

b) Periodical maintenance

For the purpose of minimising polluting emissions, maintenance of engines is to be duly carried out according to the Manufacturer's requirements.

1.3.3 Oxides of sulphur (SOx) emissions - Fuel oil management procedures (1/7/2020)

The Ship Environmental Management Plan referred to [1.4.2] is to include procedures covering the following:

- a) maximum sulphur content to be specified in the fuel oil purchase orders and to be verified in the fuel oil receipt at the delivery of bunker;
- b) laboratory check of samples of the SOx content in the bunker delivered according to a recognised standard acceptable to the Society;
- c) records of purchase orders, receipts and laboratory analysis including results are to be kept on board and made available to the Surveyor;
- d) changeover from normal to low sulphur fuel required in SOx emission control areas;
- e) maintenance of the SOx emission control system, if present on board.

1.3.4 Incinerators (1/7/2020)

a) Sludge disposal

Sludge can only be disposed of on board through incineration, according to [1.2.1] c).

Sludge disposal through incineration is to be recorded in the oil record book.

b) Procedures

The Ship Environmental Management Plan referred to in [1.4.2] is to include procedures covering:

- the operation of the incinerator(s) within the limits (e.g. temperature, humidity, ecc.) recommended by the Manufacturer
- substances not permitted to be incinerated.

1.3.5 Additional requirements for specific ship types (1/7/2020)

A ship which is classed with one or more of the following service notations:

- a) **oil tanker**
- b) **chemical tanker**
- c) **FLS tanker**
- d) **liquefied gas carrier**
- e) **combination carrier OOC**
- f) **combination carrier OBO**

is also to comply with the requirements of Ch 13, Sec 7 relative to the prevention of vapour emissions, excluding ships as per a), b), c), e) and f) intended for the carriage of products having flashpoint > 60°C.

In order for the **GREEN STAR 3** notation to be granted to such a ship, it is necessary that the **VCS** notation is also granted.

1.4 Ship Environmental Management

1.4.1 Ship Environmental Manager (1/7/2020)

A Ship Environmental Manager, as defined in [1.1.3] n), is to be available on board.

1.4.2 Ship Environmental Management Plan (1/7/2020)

An Environmental Management Plan, specific to the ship, is to be developed and made available on board.

The Manual is to contain the procedures requested in these Rules and is to include at least:

- the indication of person(s) in charge for each procedure to be carried out
- documents and manuals required
- log-books/records to be filled in
- time schedule when applicable (e.g. checking, sampling, etc.)

The Ship Environmental Management Plan is to be submitted to the Society for information.

1.5 Inspections, tests and surveys

1.5.1 Inspections and testing during construction (1/7/2020)

Materials, systems or equipment which are installed on board or modified in order to comply with the requirements of this Sec 2 are to be surveyed and tested according to the applicable Rules of the Society.

1.5.2 Initial survey (1/7/2020)

Following the satisfactory review and approval of the plans and other documentation requested in [1.1.4], an initial survey is to be carried out on board in order to:

- verify that hull and machinery arrangements are in accordance with the approved documentation;
- test, in the presence of the Surveyor and under working conditions, the equipment and systems covered by these Rules including their control, monitoring and alarms;
- verify and presence on board of the Ship Environmental Manager;
- verify the presence on board of the certificates, record and log-books, and Environmental Management Plan requested by this Sec 2;
- carry out the engine parameter check according to the engine technical file, of the engines referred to [1.5.2], d);
- for existing ships, assess and document (e.g. by photo) the satisfactory maintenance of equipment and systems.

1.5.3 Periodical surveys (1/7/2020)

During periodical surveys, the checks and inspections requested in Pt A, Ch 5, Sec 7, as applicable, are to be carried out.

SECTION 6

GREEN AND CERTIFIED CARGO HANDLING SYSTEMS (GC CARGO HANDLING SYSTEM)

1 General

1.1 Application

1.1.1

The additional class notation **GC CARGO HANDLING SYSTEM** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.8.5], to systems for handling solid cargo which may be a source of sea or air pollution (e.g. those handling coal, iron ore, sulphur, etc.), designed, built and installed to comply with the requirements of this Section.

A Certificate of Compliance may be issued to cargo handling systems fulfilling the requirements of this section and installed on ships not classed with the Society.

1.2 Documents to be submitted

1.2.1

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 system environmental 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.

2 Validation

2.1 Application

2.1.1

The cargo handling system is to be designed, approved and tested in accordance with the requirements in [2.2] and [2.3].

2.2 Design

2.2.1

The cargo handling system is to be designed according to the criteria indicated in the "Rules for the design of mobile equipment for continuous handling of bulk materials, FEM Section II" (see Note 1 to [2.2.6]) considering, in addition to the loads indicated in Chapter 2 of the above-mentioned rules, the following:

- Dynamic loads due to the ship's accelerations, considering the system in stowed position, the ship's relevant navigation notation and including the possible transit condition, too.
- Dynamic loads due to the ship's accelerations, considering the system in operating conditions with the design significant wave height and other significant parameters to be determined case by case on the basis of the specified operational requirements and relevant environmental conditions (e.g. wind).

2.2.2

The design significant wave height in operating conditions, for which the system has been designed, and the ship where the system is fitted are to be indicated on the test certificate of the cargo handling system.

2.2.3

Structural materials are to be in accordance with Part D.

2.2.4

The electrical and hydraulic parts, including any pressure vessels of the system, are to be in compliance with the requirements of Part C as applicable.

2.2.5

Classification of hazardous areas is to be carried out on the ship and relevant cargo handling system on the basis of the requirements of the IMO IMSBC Code applicable to the cargoes to be handled, IEC 60079-10-1 and IEC 60079-10-2.

Certified safe type electrical equipment and systems may be required to be installed depending on the above classification.

Table 1 : Documents to be submitted

No.	AI (1)	Document
1	I	General arrangement of the handling system
2	A	Structural drawings of the handling system
3	A	Drawings of pressure vessels (e.g. hydraulic cylinders, air pressure vessels, etc.)
4	I	Structural calculation report
5	I	Environmental management procedures (see [3.1])

(1) A = four copies to be submitted for approval; I = to be submitted for information in duplicate.

2.2.6

For the classification of hazardous areas and the choice of the relevant electrical equipment, the Society may accept national or international standards other than those mentioned above.

Note 1: When referred to by the Society, regulations, rules and standards are those currently in force at the date of contract for construction as defined in Pt A, Ch 1, Sec 1. In the case of conversion of existing ships, the regulations, rules and standards to be applied will be defined by the Society on a case by case basis.

2.3 Verification and Testing

2.3.1 General

Testing activities are to be carried out according to the requirements from [2.3.2] to [2.3.6].

Following the positive results of the testing activities, a test certificate (see also [2.2.2]) will be issued.

2.3.2 Materials

Structural materials and fittings are to be tested by the Society and the materials are to be found in compliance with the relevant standards as specified on the approved drawings.

2.3.3 Welding procedures and welder certification

Welding procedures are to be in compliance with Part D, Ch 5, Sec 4, [1].

Welders are to be certified as requested in Pt D, Ch 5, Sec 1, [2.2.3].

2.3.4 Visual inspection and non-destructive tests of structural items

All items subject to approval are to be verified for conformity to the approved drawings, inspection and testing plan. Verification is to include all the non-destructive testing to be carried on welded joints, to be agreed with the Society (e.g. with the Surveyor in charge).

2.3.5 Machinery items

The machinery of cargo handling systems is to be tested by the Manufacturer and the relevant manufacturer's statement of compliance is to be issued. Manufacturer test records are to be available upon request.

Electrical and hydraulic items which are part of the system are to be tested in accordance with Part C, Chapter 2 and Part C, Chapter 1 respectively.

2.3.6 Operational test

Operational tests are to be carried out on board after the complete installation of the cargo handling system. The tests are to include all the checks necessary to demonstrate the efficiency of safety, control and alarm systems, in particular correct behaviour of the machinery stopping equipment in both normal and emergency situations.

Disassembly and inspection of parts, after testing, may be required if deemed necessary by the Society (e.g. by the Surveyor in charge).

2.3.7 Overload test

After the complete installation of the system, loading and unloading booms are to be subjected to an overload test to be agreed with the Society on a case by case basis. For this purpose, loading and unloading booms are subject to the rules for testing included in "Rules for loading and unloading systems and other lifting appliances on board ships", as applicable. The loading or unloading booms are to be included in the relevant unit documentation as required by the competent Authority.

3 Environmental requirements

3.1 Environmental management procedures

3.1.1

Adequate environmental management procedures are to be available and training on environmental issues, including emergency response, is to be planned, carried out and documented for all people with influence on the environmental behaviour of the cargo handling systems.

3.2 Systems, components and procedural means to reduce environmental impact

3.2.1

The list of 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 index are given in the third and fourth columns of Tab 2, respectively.

Table 2 : Systems, components and procedural means to reduce environmental impact

No.	System	Pollution Source	Item	Environmental Index	References
1	Continuous unloader	Airborne dust/ spillage	Gravity system unloader	44 (83 (1))	[3.3.2]
			Screw type continuous unloader	41 (80 (1))	[3.3.3]
			Partially enclosed bucket type continuous unloader	41 (80 (1))	[3.3.4]
2	Grabs	Spillage	Green enclosed grab	12	[3.3.5]
(1) score to be assigned if no conveyor system is foreseen on board					

No.	System	Pollution Source	Item	Environmental Index	References
3	Hopper	Airborne dust	Eco-hopper	10	[3.3.6]
		Spillage	Spill plate on hopper sides	3	[3.3.7]
			Hopper top opening design	3	[3.3.8]
			Integrated controlled system to reduce overfilling from crane	6	[3.3.9]
			Hopper internal grid	1	[3.3.10]
		Airborne dust	Vibrators on hopper plates	1	[3.3.11]
			Water spray system on hopper top opening	9	[3.3.12]
			Wind breaks on hopper sides	6	[3.3.13]
		4	Feeders dozing system	Spillage	Plate feeder / Apron conveyor	3	[3.3.14]
Feeder belt	3				[3.3.15]
Spillage reclaiming system	3				[3.3.16]
5	Transfer points	Airborne dust/ spillage	Transfer point design	3	[3.3.17]
			Dust curtains at transfer points	3	[3.3.18]
			Fully enclosed transfer points	6	[3.3.19]
		Airborne dust	Bag filters	6	[3.3.20]
6	Conveyor	Airborne dust	Water spray application on conveyor belts after transfer points	4	[3.3.21]
		Airborne dust/ spillage	Belt and pulley cleaners/scrapers	6	[3.3.22]
			Belt centring devices	6	[3.3.23]
		Spillage	Belt dimensions and speed	9	[3.3.24]
			Belt sealing	3	[3.3.25]
7	Discharging boom	Airborne dust/ spillage	Covered conveyors (top)	2	[3.3.26]
			Covered conveyors (sides)	2	[3.3.27]
			Covered conveyors (bottom)	2	[3.3.28]
			Conveyor galleries	12	[3.3.29]
			Conveyor flow monitoring	3	[3.3.30]
		Airborne dust	Covered discharging boom (top)	2	[3.3.31]
			Covered discharging boom (side)	2	[3.3.32]
			Covered discharging boom (bottom)	2	[3.3.33]
			Tunnel discharging boom	12	[3.3.34]
		Airborne dust/ spillage	Water spray in discharging chutes	3	[3.3.35]
			Luffing discharging boom	6	[3.3.36]
			Trimming device	6	[3.3.37]
			Vertical telescopic chute	9	[3.3.38]
Vertical telescopic chute with aspiration	12		[3.3.39]		
(1) score to be assigned if no conveyor system is foreseen on board					

No.	System	Pollution Source	Item	Environmental Index	References
8	Complete system	Airborne dust/ spillage	Air quality monitoring system	3	[3.3.40]
			Testing on cargo qualities to identify the "dusty" cargoes	6	[3.3.41]
		Spillage	Cleaning procedure and cargo contaminated water treatment	15	[3.3.42]
		Oil and grease	Collection of spillage/ leakage of environmentally hazardous substances	6	[3.3.43]
			Cleaning procedure and cargo contaminated water treatment	5	[3.3.44]
(1) score to be assigned if no conveyor system is foreseen on board					

3.3 Applicable requirements

3.3.1 General

The applicable requirements for each additional system, component installed and procedural means adopted are given hereinafter.

3.3.2 Gravity system unloader

Cargo is to fall through remotely controlled openings positioned on the hold's bottom and to be collected by a conveyor belt system leading it to a discharging boom, specifically designed for the bulk material in use. The system is intended to be extended from the openings on the hold bottom to the first transfer point above deck.

3.3.3 Screw type continuous unloader

Cargo is lifted from the hold to the top of the unloader by the rotating motion of a screw to be positioned inside a structural pipe, achieving the transport of cargo without exposing it to the action of either wind or rain (prevention from dust and washing down). The surface of material affected by scraping is thus limited together with dust production. The system is intended to extend from the cargo collecting boom opening to the first discontinuity (either an opening, external grid, curtain, etc.) in the enclosed tunnel through which the bulk material flows.

3.3.4 Partially enclosed bucket type continuous unloader

Cargo is collected by means of a bucket chain, progressively digging the surface of the pile inside the hold. As close to the shoe-type portion of the unloader as suitable for its installation, a structural cover (gallery) is to be positioned around the unloading arm, leading possible spillages back inside the hold and preventing the collected cargo from being exposed to wind or rain (prevention from dust and washing down).

The system is intended to extend from the cargo collecting boom opening to the first discontinuity (either an opening, external grid, curtain, etc.) in the enclosed tunnel through which the bulk material flows.

3.3.5 Green enclosed grab

Grabs are to be provided with devices for preventing the material from falling during transport both to the hopper and back.

This is to be achieved by:

- applying lips manufactured in high strength steel (Hardox 500 or equivalent) on bottom and sides, purposely designed, dimensioned and machined after assembly to ensure perfect tightness between scoops even after some wear;
- designing the grab's scoop shape in order to minimize compression of the material inside the grab during closing thus minimizing the risk of spillage from the top;
- constructing grabs in AISI, which are also to be designed with bevelling plates on corners to prevent the material from adhering to the scoop's internal surface, thus reducing the fall of material while the open grab returns to the hold.

3.3.6 Eco-hopper

Hoppers are provided with a ventilating system for the containment of airborne dust generated by the material falling from the grab. The grab is lowered deep inside the hopper and when the material is dropped a forced air flow prevents dust from rising from the hopper top opening; the polluted air is then filtered and recirculated.

3.3.7 Spill plate on hopper sides

A spill plate is to be positioned on each hopper's side receiving the grab to cover the gap between the hopper and the hold from which the cargo is collected. The spill plate inclination is to be adjustable according to the operating condition and its external borders are to be folded to give the spill plate a tray shape (bulk material is not deviated inside the hold, but collected and successively thrown inside the hopper). The other sides of the hopper are to be equipped with fixed plates, again for cargo containment purposes and spillage avoidance.

3.3.8 Hopper top opening design

Hoppers are to have a top opening area designed according to the capacity and dimensions of the grab, to facilitate discharge inside it and prevent spillage.

In particular:

- The diagonal of the hopper opening surface is to be equal to or exceed the open grab maximum extension multiplied by 1,5;
- The hopper is to have a volume capacity equal to or exceeding 2.5 times the receiving grab volume capacity.

3.3.9 Integrated control system to reduce overfilling from crane

Proper level sensors are to be installed on the sides of each hopper to evaluate the actual height of the pile of material inside it and compare it to a limit value. If this value is exceeded, a signal is to be sent either to the crane operator monitor or to a warning light positioned on the hopper top (where it is always visible to the crane operator) which turns red as a warning that the pile is reaching a dimension which could lead to spilling from the hopper, and grab operations should consequently be interrupted until the volume of material is reduced to an acceptable level.

3.3.10 Hopper internal grid

A protecting grid is to be installed inside hoppers to break cohesive or high-moisture materials, facilitating cargo free flow, and to protect the conveyor system from any foreign body (bulky items, stones, metal spikes, etc.), which could possibly damage belts, creating spillage. This internal grid is to be positioned at least 1000 mm below the hopper upper edge (without considering wind breaks, if present), in order to prevent the bulk material falling on it, from spilling out of the hopper and to contain dust emission. Moreover, it is to be designed to guarantee the smooth fall of material through it according to its size and moisture and to minimize air flow back and piling up of finer material on top of the grid lines which could generate airborne dust dispersion.

3.3.11 Vibrators on hopper plates

Hopper side plates are to be equipped with suitable vibrators to be periodically operated to prevent the piling up of material on plates and corners (which might generate airborne dust dispersion) and hopper clogging (which may lead to spillage).

3.3.12 Water spray system on hopper top opening

A plant for airborne dust suppression, comprising a fresh/recycled water storage tank, an electric pump and pipes going up the hopper's structures to reach a series of nozzles oriented to the cargo discharging area is to be provided.

- a) Nozzles are to be of the "hollow cone" type, with a spacing which ensures sprayed water mist can easily cover the area affected by cargo falling. Moreover, nozzles are to be positioned so as to cross their gush in order to properly cover the entire surface of the hopper opening;
- b) The system is to be automatically activated by a sensor perceiving the incoming grab;
- c) The system should be regulated according to the cargo features (moisture and size) and wind, foreseeing the

possibility of augmenting the spraying capacity or using a mixture of water and chemical bonding additive.

3.3.13 Wind breaks on hopper sides

A wind break is to be installed on each hopper fixed vertical plate. Wind breaks are to be dimensioned so as to contain the closed grab inside the hopper and exceed it by 1.5 m. In the case of adjacent wind breaks, they are to be sealed together to avoid spillage or dust escaping in between.

3.3.14 Plate feeder / Apron conveyor

The collection and dosing of bulk material falling from the hopper is operated by a plate feeder (steel trays or plates linked by a chain) running underneath the hopper bottom opening at regulated speed. The speed regulation allows the quantity of bulk material to be maintained inside the hopper at acceptable levels, but fines can penetrate between the plates and fall on deck.

3.3.15 Feeder belt

The collection and dosing of bulk material falling from the hopper is operated by a belt running underneath the hopper bottom opening at regulated speed. The speed regulation allows the quantity of bulk material to be maintained inside the hopper at acceptable levels, and the continuity of the belt prevents fines from falling on deck.

3.3.16 Spillage reclaiming system

The feeder dosing system is positioned above a portion of a conveyor belt or a reclaiming device (either a tray to be periodically cleaned or a hopper) preventing the fall of bulk material on deck.

3.3.17 Transfer point design

The distance between the axis of drums of subsequent belts is to be to a minimum value, compatibly with the operational requirements of other installed devices (i.e. cleaners and scrapers) and the practical handling of the bulk material. Moreover, the flow of the falling material is to be deviated so as to have the same direction and versus of the receiving belt, to avoid incorrect distribution of material on the conveyor and possible spillage.

3.3.18 Dust curtains at transfer points

Transfer points between belts are to be sheltered by means of curtains for the containment of dust. These are to be removable for inspection and maintenance purposes.

3.3.19 Fully enclosed transfer points

Transfer points are to be totally enclosed by means of a rigid structure complete with rubber skirt at belt entrance and exit. The enclosed volume is to be ventilated with a negative pressure to avoid the dispersion of airborne dust. Polluted air is to be collected and filtered.

3.3.20 Bag filters

Transfer points are to be de-dusted with a pulse jet bag filter system. The bag type is to be selected according to the specific application and the filtering surface is to be designed considering the factor air cloth ratio max 1,5m/min. Dust emission measured to the stack should be less than 10mg/Nm³. Generally, vertical bag filters are preferred.

3.3.21 Water spray application on conveyor belts after transfer points

An adequate number of nozzles are to spray water mist on the conveyor starting from 2 m after each transfer point, to avoid dust rising up from the deposited cargo surface. Therefore, a plant for airborne dust suppression, including a water storage tank, an electric pump and pipes reaching the nozzles is to be provided, having the following characteristics:

- a) nozzles are to be in a position suitable to distribute water homogeneously on the surface of material laid on the outcoming belt;
- b) water mist is to be continuously applied when the conveyor system is running, unless cargo is already characterized by a sufficient moisture level and dust is not likely to disperse;
- c) the system is to be regulated according to the cargo features (moisture and size) and wind, foreseeing the possibility of augmenting the spraying capacity or using a mixture of water and chemical bonding additive.

3.3.22 Belt and pulley cleaners/scrapers

Conveyors are to be provided with primary cleaners and secondary cleaners to be situated at the discharging end of the belt, suitable for the material and in number, dimension, material and type, to prevent carry-back of material. Scraped material is to be collected into a tray/discharging hopper.

Moreover, a V-plow cleaner is to be installed on the idle drum. Additional scrapers can be installed and counted for extra points (1 point for each scraper).

The effectiveness of the selected cleaners/scrapers is to be tested during operations.

3.3.23 Belt and pulley cleaners/scrapers

To avoid spillage of material due to misalignment of the belt, suitable upper and lower self-centring idlers (or other effective devices/design solutions) are to be installed at least every 30 m minimum.

3.3.24 Belt dimensions and speed

The speed of all belts is to be adjustable according to the actual flow of bulk material, cargo features (size and moisture) and weather conditions, but in any case kept lower than 3 m/s. The belt design filling factor is not to exceed 65%, provided idler inclination does not exceed 35°.

3.3.25 Belt sealing

At transfer points and main hoppers, bulk material falling on belts is to be prevented from being transversally dispersed by means of a proper multiple rubber sealing. A sort of labyrinth path is to be obtained by duly positioning the various sealings to avoid cargo damaging the most external one.

3.3.26 Covered conveyors (top)

The conveyor system is to be provided with top shelters covering the entire length of the conveyor belts. These shelters are to be designed so that the bottom edge reaches under the belt's idlers and pulley structure, protecting the cargo from rain and preventing the wind from lifting dust,

but still allowing for periodical inspection, and are to be removable for maintenance purposes.

3.3.27 Covered conveyors (sides)

The conveyor system is protected by plates positioned on the sides and sufficient in size to avoid dust being lifted by the wind.

3.3.28 Covered conveyors (bottom)

A collecting tray is to be fitted under the conveyor belt for its whole extension, to prevent possible spillage from falling directly into the sea or from piling up on deck and underneath structures, which could result in spillage and dust.

3.3.29 Conveyor galleries

The whole conveyor system runs inside a water and wind proof tunnel, which is to be designed and dimensioned to allow periodical inspection, maintenance and cleaning. The inside is to be duly illuminated and accesses placed according to safety reasons. Material which has fallen from the conveyor belts is therefore contained and can be periodically collected and returned to the cargo handling cycle, while air dust due to wind action is avoided.

A ventilating plant is to be integrated for safety reasons and the air moved through filters before leaving the tunnel. Fresh air is to be supplied by performing from 6 to 10 recycles per hour.

3.3.30 Conveyor flow monitoring

A system of cameras sending images to a remote control room are to be fitted at transfer points and along conveyor belts, allowing constant monitoring with the aim of immediately interrupting operations in the case of unexpected deviation from normal operation.

3.3.31 Covered discharging boom (top)

The discharging boom is to be provided with top shelters covering the entire length of the discharging belt. These shelters are to be designed so that the bottom edge reaches under the belt's idlers and pulley structure, protecting the cargo from rain and preventing the wind from lifting dust, but still allowing periodical inspection, and are to be removable for maintenance purposes. In the case of a telescopic boom, covers are not to interfere with its operability but are still to guarantee that the entire extension of the discharging boom is sheltered.

3.3.32 Covered discharging boom (side)

The discharging boom is protected by plates positioned on the sides and in sufficient size to avoid dust being lifted by the wind. In the case of a telescopic boom, covers are not to interfere with its operability but are still to guarantee that the entire extension of the discharging boom is sheltered.

3.3.33 Covered discharging boom (bottom)

A collecting plate is to be fitted under the discharging boom for its whole extension, to prevent spillage into the sea or on deck, avoiding the piling up of cargo which could result in spillage and dust.

In the case of a telescopic boom, covers are not to interfere with its operability but are still to guarantee that the entire extension of the discharging boom is sheltered.

3.3.34 Tunnel discharging boom

The discharging conveyor system is to run inside a water and wind proof tunnel, which is to be designed and dimensioned to allow periodical inspection, maintenance and cleaning. The inside is to be duly illuminated and accesses placed according to safety reasons. Material which has fallen from the conveyor belts is therefore contained and can be periodically collected and returned to the cargo handling cycle, while air dust due to wind action is avoided.

A ventilating plant is to be integrated for safety reasons and the air moved through filters before leaving the tunnel. Fresh air is to be supplied by performing from 6 to 10 recycles per hour.

3.3.35 Water spray at discharging chute

A plant for airborne dust suppression, comprising a water storage tank, an electric pump and pipes reaching a series of nozzles distributed on the discharging chute is to be provided.

- a) nozzles are to be fitted in sufficient number so that sprayed water can easily cover the material falling from the chute;
- b) the water mist is to be continuously applied when cargo is flowing, unless cargo is already characterized by a sufficient moisture level and dust is not likely to disperse;
- c) the system is to be regulated according to the cargo features (moisture and size) and wind, foreseeing the possibility of augmenting the spraying capacity or using a mixture of water and chemical bonding additive.

3.3.36 Luffing discharging boom

Luffing shiploaders are considered to limit both spillage and airborne dust as a result of their ability to go deeper inside holds, reducing the falling height of the material. A ship-loader is considered to be luffing if it can reach luffing angles in a range from 5° to the greatest possible angle according to the bulk material to be handled below the horizontal position.

3.3.37 Trimming device

The discharging chute is complete with a trimming device to convey the falling bulk material properly, thus reducing the drop height and the irregularity of the flow.

3.3.38 Vertical telescopic chute

The chute is to be enclosed in a telescopic tube complete with rubber skirt at the discharging end to properly cover the pile of cargo. A level sensor is to be foreseen to allow the rubber to automatically position itself as low as possible, so as to minimize the generation of dust.

3.3.39 Vertical telescopic chute with aspiration

The chute is to be enclosed in a telescopic tube complete with rubber skirt at the discharging end to properly cover the pile of cargo. A level sensor is to be foreseen to allow the rubber to automatically position itself as low as possible, so as to minimize the generation of dust. Moreover, the dust produced inside the rubber skirt or nearby is aspirated and led to filters.

3.3.40 Air quality monitoring system

The measuring equipment necessary to periodically measure and record data about dust dispersed in the air is to be available on board. The measurements are to be relevant to immediately identify failures or misbehaviour in the dust containment/suppression system. In this case, operations are to be immediately stopped and the normal operating conditions restored.

The position of the airborne dust detectors is to be defined on a case by case basis according to the cargo handling system layout.

3.3.41 Testing of cargo qualities to identify the "dusty" cargoes

The moisture level and size of cargo is to be evaluated to adjust the cargo handling system to suitably handle it with regard to water sprinkle flow rate, conveyor system speed and filling capacity, etc.

3.3.42 Cleaning procedure and cargo contaminated water treatment

Spillage residues on deck are to be periodically washed away and resulting wastewater is to be collected in settling tanks for depuration, together with polluted water coming from the periodical cleaning of the system, and from the water spray system (preventing polluted water from being discharged at sea). A dedicated pump and pipeline plant is to be used only for this purpose. During the washing operation, outboard scuppers are to be temporarily closed, while the washed down material is directed to suitably designed settling tanks. Clean water is to be obtained by gravity settling, or centrifugal depuration and then recycled, while the residual material can be treated as cargo and handled consequently. The use of chemical flocculating substances to facilitate gravity settling will be considered on a case by case basis.

3.3.43 Collection of spillage/leakage of environmentally hazardous substances

Adequate gutters for the collection of spillages or leakages from cargo handling machinery are to be foreseen. A draining system is to be provided, capable of discharging the sludge from the gutters to the sludge tank. Discharge lines are to be sized to allow pumping by means of a power operated pump, without the need to heat the sludge.

3.3.44 Biodegradable and low toxicity lubricants

Biodegradable and low aquatic toxicity oils are to be used for the lubrication of cargo handling machinery and its hydraulic systems. The oil biodegradability characteristic and low aquatic toxicity are to be demonstrated by means of tests carried out according to a recognized standard.

3.4 Assignment Criteria

3.4.1

The environmental index is obtained by adding up the values of the contributions for each system, component and procedural means (items) the cargo handling system is equipped with, according to Tab 2.

3.4.2

The additional class notation **GC CARGO HANDLING SYSTEM** is assigned to a ship having a cargo handling system

- a) complying with [2] and [3.1]
- b) having an environmental index calculated in accordance with [3.4.1] greater than or equal to 100.

3.5 Novel features

3.5.1

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.

APPENDIX 1 DEFINITIONS RELEVANT THE GREEN PLUS NOTATION

1 General

1.1 MARPOL 73/78

1.1.1

MARPOL 73/78 is the IMO "International Convention for the Prevention of Pollution from Ships, 1973/78", including the Annexes from I to VI as amended.

1.2 Ship Environmental Manager

1.2.1

The Ship Environmental Manager is an officer in service on board, in charge of the management and control of the procedures and activities relevant to the requirements of this Chapter.

1.3 Ship recycling

1.3.1 (1/1/2020)

The terms regarding ship recycling used in this Chapter have the meaning provided in the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships 2009 and in IMO Resolution MEPC.269(68) "2015 Guidelines for the development of the inventory of hazardous materials" and EU Ship Recycling Regulation n° 1257/2013.

2 Definitions in connection with prevention of sea pollution

2.1 Discharge

2.1.1

Discharge, in relation to harmful substances or effluents containing such substances, means any release, howsoever caused, from a ship and includes any escape, disposal, spillage, leakage, pumping, emitting or emptying.

Discharge does not include:

- dumping, within the meaning of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, London 13 November 1972, or
- release of harmful substances directly arising from the exploration, exploitation and associated offshore processing of seabed mineral resources, or
- release of harmful substances for purposes of legitimate scientific research into pollution abatement or control.

2.2 Grey water

2.2.1

Grey water means drainage from dishwasher, galley, shower, laundry, bath, washbasin drains and toilette scuppers.

2.3 Grey water - Maximum number of persons

2.3.1

Maximum number of persons on board, for the purpose of calculating grey water retention capacity for ro-ro passenger ships, means the maximum number of passengers that can be accommodated in cabins plus the crew.

2.4 Harmful aquatic organisms and pathogens

2.4.1

Harmful aquatic organisms and pathogens means bacteria, plants and animals which can survive in a viable form in the ballast water and sediments carried in ships.

2.5 Harmful substance

2.5.1

Harmful substance means any substance which, if introduced into the sea, is liable to create hazards to human health, harm living resources and marine life, damage amenities or interfere with other legitimate uses of the sea, and includes any substance subject to control by MARPOL 73/78.

2.6 Harmful substances carried in packaged form

2.6.1

Harmful substances are those substances which are identified as marine pollutants in the International Maritime Dangerous Goods Code (IMDG Code) as amended. Packaged form is the form of containment specified for harmful substances in the IMDG Code.

2.7 TBT free antifouling system

2.7.1

Antifouling system means a coating, paint, surface treatment or device used to control or prevent attachment of organisms.

TBT-free antifouling system means an antifouling system in compliance with the IMO Resolution MEPC.102(48) as amended.

2.8 Treated sewage holding tank

2.8.1

Treated sewage holding tank means a tank used for the collection and storage of the effluent of the sewage treatment plant.

2.9 AFS Certificate

2.9.1 (1/1/2020)

AFS Certificate means "International Antifouling System Certificate" or statement of compliance, issued in accordance with IMO Resolution MEPC.195(61) "2010 Guidelines for survey and certification of anti-fouling systems on ships", as amended.

3 Definitions in connection with prevention of air pollution

3.1 Cold Ironing

3.1.1

Cold Ironing is the 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.

3.2 Gas to liquid fuels (GTL)

3.2.1

Gas to liquid fuels are those fuels obtained according a refinery process which converts natural gas or other gaseous hydrocarbons into longer-chain hydrocarbons.

3.3 Global Warming Potential (GWP)

3.3.1

Global Warming Potential is the potential global warming effect of a gas compared with CO₂ on a time horizon of 100 years.

3.4 Green House Gases (GHGs)

3.4.1

A Green House Gas is any gas, such as carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), chloro fluoro

carbon compounds (CFCs) that contribute to the greenhouse effect when released into the atmosphere.

3.5 Liquefied Natural Gas (LNG)

3.5.1

Liquefied natural gas or LNG is natural gas (primarily methane, CH₄) that has been converted to liquid form for ease of storage or transport.

3.6 Low energy consumption lights

3.6.1

Low energy consumption lights are lights other than incandescent light bulbs, halogen lamps and those having similar lum/W ratio, recognized by appropriate national or international standards.

3.7 Ozone Depleting Potential (ODP)

3.7.1

Ozone Depleting Potential is the potential of ozone depletion compared to CFC 11. Values of ODP for ozone depleting gases are provided in the "Montreal Protocol on Substances that Deplete the Ozone Layer".

3.8 Particulates (PMs)

3.8.1

Particulates, alternatively referred to as particulate matter (PM) or fine particles, are tiny particles of solid or liquid suspended in a gas.

3.9 Second generation bio-fuels

3.9.1

Second generation bio-fuels are those 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 CO₂ emissions of over 85% compared to fossil fuels.

APPENDIX 2

BASIC AND ADDITIONAL SYSTEMS, COMPONENTS AND PROCEDURAL MEANS TO EVALUATE THE SHIP'S ENVIRONMENTAL INDEX AS PER THE GREEN PLUS NOTATION

1 Prevention of sea pollution

1.1 Oil from machinery spaces

1.1.1 Bilge Water Treatment (15 ppm with alarm and automatic stop)

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 re-circulated to the bilge water holding tank (see [1.1.4] and Sec 1, [5.1.1], second sentence).

1.1.2 Bilge Water Treatment (5 ppm with alarm and automatic stop)

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 re-circulated to the bilge water holding tank, see [1.1.4].

1.1.3 Bilge Water Treatment (5 ppm with alarm, automatic stop and recorder)

In addition to [1.1.2] 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 shut-down 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).

1.1.4 Bilge oil tank

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 $15^\circ C$ greater than $0,94 \text{ kg/dm}^3$ and viscosity at $50^\circ C$ 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.

1.1.5 Retention on board

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/dm³ and viscosity at 50°C greater than 110 centistokes, this tank is to be provided with heating arrangements.

In the case of ships operating at a fixed location, the minimum total capacity of the holding tank(s) is (are) to be based on the type of ship and its machinery considering the maximum possible day interval between two ashore disposals.

A high level alarm is to be given in a manned position.

1.1.6 Restrictions in the use of ship's tanks for ballast

The use of tanks intended for fuel oil as ballast tanks is not allowed, irrespective of their volume.

1.1.7 Fuel oil tank protection by means of tank boundary distance from the ship side and bottom

The protection of the tanks is to be achieved applying the criteria of MARPOL Annex I Reg. 12A based on the distance of the fuel oil tank boundary from the ship side and bottom.

If the adoption of fuel oil tank protection criteria is compulsory for the ship concerned, no contribution to the ship's environmental index will be considered for fuel oil tank protection, (see Sec 1, [5.1.1], second sentence).

1.1.8 Fuel oil tank protection by means of outflow calculation

The protection of the tanks is to be achieved applying the criteria of MARPOL Annex I Reg. 12A based upon outflow calculation.

If the adoption of fuel oil tank protection criteria is compulsory for the concerned ship, no contribution to the ship's environmental index will be considered for fuel oil tank protection, (see Sec 1, [5.1.1], second sentence).

1.1.9 Lubricating oil and sludge tank protection by means of tank boundary distance from the ship side and bottom

The protection of the tanks (having a capacity of 20 m³ and above) is to be achieved applying the criteria of MARPOL, Annex I, Reg. 12A (independently from their total aggregate capacity) 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.

1.1.10 Lubricating oil and sludge tank protection by means of outflow calculation

The protection of the tanks (having a capacity of 20 m³ and above) is to be achieved applying the criteria of MARPOL Annex I Reg. 12A (independently from their total aggregate capacity) based upon outflow calculation.

The requirement is not applicable to the double bottom for lubricating oil located under the main engine.

1.1.11 Oil tank overflow

a) All fuel oil and lubricating oil tanks of capacity greater than 10 m³ 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.

1.1.12 Gutters

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.

1.1.13 Dry bilge concept

An adequate number of tanks of 1 m³ 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.

1.1.14 Sludge oil collection and handling facilities

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.

1.1.15 Water-lubricated stern tube bearings

Stern tube bearings are to be water lubricated according to Pt C, Ch 1, Sec 7, [2.4.3], [2.4.4] and [2.4.7].

1.1.16 Magnetic coupling on oil pumps

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.

1.1.17 Biodegradable and low aquatic toxicity lube oil (1/1/2020)

Biodegradable and low aquatic toxicity oils are to be used for the lubrication of machineries, apart from diesel engines, and for hydraulic systems. The oil biodegradability characteristic and low aquatic toxicity are to be demonstrated by means of tests carried out according to a recognized standard from a laboratory certified in accordance to ISO 17025 "General requirements for the competence of testing and calibration laboratories".

Products labelled by Blue Angel, European Ecolabel or Nordic Swan labelling programs, will be automatically recognized as biodegradable and low aquatic toxicity oils.

1.1.18 Restrictions in the use of hydraulic plants

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.

1.1.19 Electronic Oil Record Book (1/1/2020)

In order to avoid any data oversight due to manual input errors and to increase data integrity and accuracy, the Oil Record Book part I as required by MARPOL Annex I Regulation 17, is to be replaced by an electronic record book. An anti-tampering mechanism is to be implemented in the system and each action is to be confirmed by a signature based on user's credentials and biometric details (i.e. fingerprint). The system is to be approved by Flag Administration.

The electronic record book is to be in compliance with Resolution MEPC.312(74) "Guidelines for the use of electronic record books under MARPOL".

1.2 Solid bulk cargo storage

1.2.1 System to minimize the dispersion of cargo environmentally hazardous dust

The ship is to be provided with means, additional to those required for compliance with the International Load Line

Convention, capable of minimizing the dispersion of cargo dust into the sea.

These means may be structural defence against wind, cargo covering means, closure means or a combination of these.

Any other means will be specially considered.

1.2.2 Cargo moisture level increasing systems

When permitted by the type of stored cargo, the ship is to be provided with a fixed spraying system capable of increasing the cargo moisture level.

Dirty waters generated from the dust suppression systems are to be conveyed to a drainage system and disposed ashore.

1.3 Sewage

1.3.1 Treatment plant: effluent quality as per IMO MEPC.2(VI) (1/1/2020)

A sewage treatment plant, meeting operational requirements based on the standards and test methods as detailed in Resolution MEPC.2(VI) is to be installed on board (for plants installed before 1 January 2010).

The system performance is to be certified.

1.3.2 Treatment plant: effluent quality as per IMO MEPC.159(55) (1/1/2020)

A sewage treatment plant, meeting operational requirements based on the standards and test methods as detailed in Resolution MEPC.159(55) is to be installed on board (for plants installed on or after 1 January 2010).

The system performance is to be certified.

1.3.3 Treatment plant: effluent quality as per IMO MEPC.227(64) except for paragraph 4.2 (1/1/2020)

A sewage treatment plant, meeting operational requirements based on the standards and test methods as detailed in Resolution MEPC.227(64) as amended is to be installed on board. except requirements in [4.2] about effluent standards for sewage effluent discharge in special areas.

The system performance is to be certified.

1.3.4 Treatment plant: effluent quality as per IMO MEPC.227(64) including paragraph 4.2 (1/1/2020)

A sewage treatment plant, meeting operational requirements based on the standards and test methods as detailed in Resolution MEPC.227(64) as amended is to be installed on board including requirements in [4.2] about effluent standards for sewage effluent discharge in special areas.

The system performance is to be certified.

1.3.5 Holding tank

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 be 2 days based on the maximum number of persons on board and 96 litres/person/day if a conventional (flush-meter) system is used and 11 litres/person/day if a vacuum system is used.

A high level alarm is to be given in a manned position.

1.3.6 Retention on board

The ship is to be equipped with holding tank(s) for treated sewage having a minimum total capacity evaluated on the maximum possible duration of voyage, the maximum number of persons on board and 96 litres/ person/ day if a conventional (flush-meter) system is used and 11 litres/ person/ day if a vacuum system is used.

The treated sewage is to be stored in the holding tank(s) for subsequent disposal ashore to dedicated reception facilities through the standard discharge connection referred to in regulation 10, Annex IV to MARPOL 73/78 as amended, or any other approved means of disposal.

In the case of ships operating at a fixed location, the minimum total capacity of the holding tank(s) is to be based on the above criteria for the maximum possible day interval between two ashore disposals.

A high level alarm is to be given in a manned position.

1.3.7 Sewage record book

All sewage discharges whether to sea or shore reception facilities are to be recorded in the sewage record book with indication of the date, location and quantity of sewage discharged, and are to comply with Annex IV to MARPOL 73/78 as amended.

1.3.8 Electronic sewage record book (1/1/2020)

In order to avoid any data oversight due to manual input errors and to increase data integrity and accuracy, the sewage record book is to be replaced by an electronic record book. An anti-tampering mechanism is to be implemented in the system and each action is to be confirmed by a signature based on user's credentials and biometric details (i.e. fingerprint). The system is to be approved by Flag Administration

1.4 Grey water

1.4.1 Treatment plant: effluent quality as per IMO MEPC.2(VI) (1/1/2020)

A grey water treatment plant, meeting operational requirements based on the standards and test methods as detailed in Resolution MEPC.2(VI) is to be installed on board (for plants installed before 1 January 2010).

The system performance is to be certified.

1.4.2 Treatment plant: effluent quality as per IMO MEPC.159(55) (1/1/2020)

A grey water treatment plant, meeting operational requirements based on the standards and test methods as detailed in Resolution MEPC.159(55) is to be installed on board (for plants installed on or after 1 January 2010).

The system performance is to be certified.

1.4.3 Treatment plant: effluent quality as per IMO MEPC.227(64) except for paragraph 4.2 (1/1/2020)

A grey water treatment plant, meeting operational requirements based on the standards and test methods as detailed in Resolution MEPC.227(64) as amended is to be installed on board except requirements in [4.2] about effluent standards for sewage effluent discharge in special areas.

The system performance is to be certified.

1.4.4 Treatment plant: effluent quality as per IMO MEPC.227(64) including paragraph [4.2] (1/1/2020)

A grey water treatment plant, meeting operational requirements based on the standards and test methods as detailed in Resolution MEPC.227(64) as amended is to be installed on board including requirements in [4.2] about effluent standards for sewage effluent discharge in special areas.

The system performance is to be certified.

1.4.5 Holding tank

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 (see App 1, [2.3]) on board 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 [1.3.4] 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.

1.4.6 Retention on board

The ship is to be equipped with holding tank(s) for all grey waters that are to be drained and stored in the holding tank(s) for subsequent discharge ashore to dedicated reception facilities.

The holding tank is to have a minimum total capacity based on the maximum possible duration of the voyage, the maximum number of persons on board and 200 litres/ person/ day.

In the case of ships operating at a fixed location, the minimum total capacity of the holding tank(s) is to be based on the above criteria for the maximum possible day interval between two ashore disposals.

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 [1.3.4] and the tanks for grey water.

1.4.7 Grey water record book

All grey water discharges whether to sea or shore reception facilities are to be recorded in the grey water record book with indication of the date, location and quantity of grey water discharged. If the grey water is discharged to sea, the records are to include information on distance to the nearest land.

1.4.8 Electronic Grey water record book (1/1/2020)

In order to avoid any data oversight due to manual input errors and to increase data integrity and accuracy, the grey water record book is to be replaced by an electronic record book. An anti-tampering mechanism is to be implemented in the system and each action is to be confirmed by a signature based on user's credentials and biometric details (i.e. fingerprint).

1.5 Garbage

1.5.1 Garbage Management Plan

The Garbage Management Plan is to be submitted for approval.

For passenger ships, special consideration in the garbage management plan is to be given to potentially hazardous wastes, such as:

- photographic and x-ray development wastes
- dry-cleaning solvent wastes
- print shop wastes
- photocopying and printer cartridges
- unused pharmaceuticals
- batteries
- lamp bulbs.

1.5.2 Recycling

The amount of waste landed for recycling is to be recorded in the garbage record book, and different wastes are to be collected and landed separately.

For the purpose of this Rule, recyclable wastes include but are not limited to:

- Plastic
- Aluminium
- Glass
- Paper-Cardboard.

For passenger ships:

- a) a strategy of waste recycling is to be foreseen, adopted and documented;
- b) the minimum total quantity of wastes landed for recycling (W_r) is to be 50% of recyclable wastes produced on board (W_b), where $W_b = 40 \text{ Kg/person/year}$ based on the number of persons the ship is certified to carry.

1.5.3 Advanced recycling

The garbage collection systems are to be designed and installed to facilitate the efficient collection of all wet waste and dry waste generated onboard and to treat such waste in the most effective and environmentally-friendly manner. All recyclable wastes are to be separated for type and treated to reduce volume and consent offloading ashore for recycling. As far as the technology allows, all processes are to be fully automatic and continuous.

1.5.4 Electronic Garbage Record Book (1/1/2020)

In order to avoid any data oversight due to manual input errors and to increase data integrity and accuracy, the Garbage Record Book as required by MARPOL Annex V Regulation 10, is to be replaced by an electronic record book. An anti-tampering mechanism is to be implemented in the system and each action is to be confirmed by a signature based on user's credentials and biometric details (i.e. fingerprint). The system is to be approved by Flag Administration.

The electronic record book is to be in compliance with Resolution MEPC.312(74) Guidelines for the use of electronic record books under MARPOL

1.5.5 Plastic litter (1/1/2020)

In order to prevent marine plastic pollution from ship, best practise about the use of plastic on board are to be implemented, e.g. single-use plastics ban onboard. KPIs are to be identified and verified.

1.6 Other sources

1.6.1 Ballast water treatment (1/1/2020)

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, including the System Design Limitations (SDL) according to BWM.2/Circ.69 "Guidance on System Design Limitations of ballast water management systems and their monitoring".

1.6.2 Ballast water treatment without chemical (1/1/2020)

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", with filtration unit and without active chemicals (sodium chlorite, sodium hypochlorite, chlorine dioxide, peracetic acid, etc) is to be installed onboard.

The system performance is to be certified, including the System Design Limitations (SDL) according to BWM.2/Circ.69 "Guidance on System Design Limitations of ballast water management systems and their monitoring".

1.6.3 Marine growth prevention systems (1/1/2020)

Antifouling systems for pipings are to be based on environmentally friendly technologies, not discharging harmful products and approved by the Society.

Marine growth prevention systems are to be without biocides release, e.g. systems based on ultrasonics, low level pulsed laser, etc. or with a release of minimum biocide, e.g. in case of copper ions, maximum release is to be less than 2 ppb.

1.6.4 Collection of spillage/ leakage of environmentally hazardous substances

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.

1.6.5 Biodegradable and low aquatic toxicity lubricants (1/1/2020)

Biodegradable and low aquatic toxicity oils are to be used for the lubrication of machineries and for hydraulic systems installed on open decks. The oil biodegradability characteristic and low aquatic toxicity are to be demonstrated by means of tests carried out according to a recognized standard from a laboratory certified in accordance to ISO 17025 "General requirements for the competence of testing and calibration laboratories".

Products labeled by Blue Angel, European Ecolabel or Nordic Swan labeling programs, will be automatically recognized as biodegradable and low aquatic toxicity oils.

1.6.6 Limitation of hot water discharge

Limitation of hot water discharge is applicable only to ships intended to operate at a fixed location.

The temperature rise of cooling water (inlet - outlet) is to be:

- less than 5°C or
- such as not to increase by more than 2°C the seawater temperature at the edge of the defined mixing zone or within 100 meters of the discharge point.

1.6.7 Retention of dirty water from cargo area

Dirty waters (e.g. those generated from the dust suppression systems) are to be conveyed to a drainage system and disposed ashore.

1.6.8 Electronic Cargo Record Book (1/1/2020)

In case of ships certified to carry noxious liquid substances in bulk carry, in order to avoid any data oversight due to manual input errors and to increase data integrity and accuracy, the Cargo Record Book as required by MARPOL Annex II Regulation 15, is to be replaced by an electronic record book. An anti-tampering mechanism is to be implemented in the system and each action is to be confirmed by a signature based on user's credentials and biometric details (i.e. fingerprint). The system is to be approved by Flag Administration.

The electronic record book is to be in compliance with Resolution MEPC.312(74) Guidelines for the use of electronic record books under MARPOL

1.6.9 Electronic Ballast Water Record Book (1/1/2020)

In order to avoid any data oversight due to manual input errors and to increase data integrity and accuracy, the Ballast Water Record Book as required by BWMC, Regulation B-2, is to be replaced by an electronic record book. An anti-tampering mechanism is to be implemented in the system and each action is to be confirmed by a signature based on user's credentials and biometric details (i.e. fingerprint). The system is to be approved by Flag Administration

1.6.10 Bleed-off water from Exhaust Gas Recirculation (1/1/2020)

In case an Exhaust Gas Recirculation (EGR) systems is installed, the management of bleed-off water from Exhaust Gas Recirculation (EGR) systems is to be in accordance with Resolution MEPC 307(73) "2018 Guidelines for the discharge of exhaust gas recirculation (EGR) bleed-off water" as amended.

1.6.11 Biofouling Management Plan (1/1/2020)

A Biofouling Management Plan and Biofouling Record Book are to be implemented and maintained according to Resolution MEPC.207(62) "2011 Guidelines for the control and management of ships' biofouling to minimize the transfer of invasive aquatic species",

2 Prevention of air pollution**2.1 Ozone depleting substances****2.1.1 Refrigerating facilities**

The following requirements apply to ships with refrigerating facilities, such as refrigerated cargo ships, liquefied gas carriers with reliquefaction plants, and other ships with centralised cargo refrigeration systems.

They also apply to:

- centralised refrigeration systems for provision stores
- centralised air conditioning plants.

They do not apply to domestic type stand-alone refrigerators and air conditioning units.

Means are to be provided to limit leaks to the atmosphere of refrigerants or their vapours in the event of failure of the plant, as well as in the case of discharge of refrigerant to an onshore reception facility.

Annual refrigerant leakage is to be less than 10% of the total refrigerant charge of each system.

The system is to be fitted with evacuation (e.g. compressors) and retention facilities having the capacity to retain all the refrigerants, should the need to evacuate the whole plant arise in an emergency.

The plant is to be designed in such a way as to minimise the risk of medium release in the case of maintenance, repair or servicing; i.e. it is to be designed considering the possibility of isolating those sections which are to be serviced by a system of valves and bypasses, in such a way as not to stop the operation of the plant while in service, preventing the risk of release of the medium outside of the plant.

Materials for piping and equipment specifically designed to limit the emission of refrigerants are to be tested in accord-

ance with the applicable requirements for testing materials intended to be used for the construction of similar types of piping and equipment and their classes and/or design conditions.

Piping and equipment specifically designed to limit the emission of refrigerants are to be inspected and tested during fabrication in accordance with the requirements applicable to similar types of piping or equipment and their classes and/or design conditions.

After installation on board, the plant acceptance trials are to include the operation of the evacuation of the entire refrigerant from the plant to the reception facilities without any release of refrigerant and/or refrigerant vapours. The control, monitoring and alarm systems are also to be tested in the presence of the Surveyor, or their functioning is to be simulated by a procedure agreed with the Society.

2.1.2 Electronic Ozone-depleting Substances Record Book (1/1/2020)

In order to avoid any data oversight due to manual input errors and to increase data integrity and accuracy, the Ozone-depleting Substances Record Book as required by MARPOL Annex VI Regulation 12, is to be replaced by an electronic record book. An anti-tampering mechanism is to be implemented in the system and each action is to be confirmed by a signature based on user's credentials and biometric details (i.e. fingerprint). The system is to be approved by Flag Administration.

The electronic record book is to be in compliance with Resolution MEPC.312(74) "Guidelines for the use of electronic record books under MARPOL".

2.1.3 Restrictions in the use of GWP substances (1/1/2020)

Two alternatives may be chosen:

- avoid the use of refrigerants having GWP > 150 in refrigeration or air conditioning plant systems;
- 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:

$$R = (P_{TOT} - P_{GWP>150}) / P_{TOT}$$

Where:

$P_{GWP>150}$ = Refrigerating capacity at -10°C evaporating temperature and +25°C condensing temperature of refrigerating plants utilising refrigerants with GWP > 150 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].

2.1.4 Refrigerating system without fluorinated greenhouse gases (1/1/2020)

Refrigerating system without fluorinated greenhouse gases is to be installed on board (i.e. CO₂ as refrigerant). Energy efficiency is to be comparable (± 20%) to the traditional refrigerants systems.

2.2 Green House Gases and Pollutants

2.2.1 Non fossil fuels (1/1/2020)

Where power on board is partially or totally produced with systems which do not use fossil fuels (e.g. sails, batteries, fuel cells, etc.), the environmental index in Sec 1, Tab 2 is weighted multiplying by R, defined as follows:

$$R = \Sigma P_{\text{non fossil fuels}} / \Sigma P_{TOT}$$

Where:

$P_{\text{non fossil fuels}}$ = 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

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:

$$R = \Sigma P_{\text{sgbf}} / \Sigma P_{TOT}$$

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 (1/1/2020)

The ship is to be provided with the Additional class notation HVSC.

2.2.4 Zero emissions in port (1/1/2020)

The ship is equipped with systems installed on board (e.g. batteries) designed to grant zero emissions in port (time of layout in port and electric load according to ship typical operating profile).

2.2.5 Tool to manage handling and consumption of fuels

The ship is to be provided with a system to monitor and record:

- fuel supplies to the ship and
- fuel consumption of the ship.

Data may be inserted manually.

2.2.6 Computerized system to monitor fuel consumption

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).

2.2.7 Support tool to assist the Master in keeping most efficient sailing draft and trim

The ship is to be fitted with means capable to support the Master in keeping most efficient sailing draft and trim.

2.2.8 Energy saving and energy conservation

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.

2.2.9 Fuel consumption Decision Support Solution

The ship is to be provided with a correlation study, acceptable to the Society, among the parameters listed in [2.2.7] 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.

2.2.10 Optimization of Air Conditioning (AC) plant (1/1/2020)

Means are to be provided to optimize AC plant, including the use of passive means to decrease AC demand (e.g. reflective glazing or variable speed drives for electrical machines).

2.2.11 Low energy consumption lights

At least 80% in power of the lighting fittings is to be of low consumption type.

2.2.12 Variable speed drives (1/1/2020)

Variable speed drives are installed for pumps and ventilators for at least 80% in power.

2.2.13 Hull transom design

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.

2.2.14 Stabilizer openings

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.

2.2.15 Silicone-based antifouling paint

A silicone-based paint, which decreases the hull frictional resistance, is to be used as hull antifouling system.

2.2.16 Fluor-polymer antifouling paint

A fluor-polymer-based paint, which decreases the frictional resistance, is to be used as hull antifouling system.

2.2.17 Fins on propeller boss cups

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.

2.2.18 High-performing propellers

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.

2.2.19 High-efficiency motors

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

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

2.2.20 Air lubrication system (1/1/2020)

An air lubrication system distributing air bubbles under the hull is to be installed onboard according to Pt F, Ch 13, Sec 31.

2.3 Nitrogen Oxides

2.3.1 Gas to liquids (GTL) fuels

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.

2.3.2 Fossil fuel pre-treatment (e.g. water emulsion), or water injection into combustion chamber, or scavenging air, or combination of these

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 1, 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.

2.3.3 Dual-fuel engines running with LNG

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.

2.3.4 Exhaust gas treatment

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 1, [8] as applicable.

Depending on installation a weighted index may be necessary.

2.3.5 NOx emissions monitoring and recording

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 1, [8] as applicable.

2.3.6 Electronic Record Book of Engine Parameters (1/1/2020)

In order to avoid any data oversight due to manual input errors and to increase data integrity and accuracy, the Record Book of Engine Parameters as required by NOX Technical Code, paragraph 6.2.2.7, is to be replaced by an electronic record book. An anti-tampering mechanism is to be implemented in the system and each action is to be confirmed by a signature based on user's credentials and biometric details (i.e. fingerprint). The system is to be approved by Flag Administration.

The electronic record book is to be in compliance with Resolution MEPC.312(74) Guidelines for the use of electronic record books under MARPOL.

2.3.7 Electronic tier and on/off status of marine diesel engines Record Book (1/1/2020)

In order to avoid any data oversight due to manual input errors and to increase data integrity and accuracy, the Record Book of tier and on/off status of marine diesel engines, as required by MARPOL Annex VI, regulation 13.5.3, is to be replaced by an electronic record book. An anti-tampering mechanism is to be implemented in the system and each action is to be confirmed by a signature based on user's credentials and biometric details (i.e. fingerprint). The system is to be approved by Flag Administration.

The electronic record book is to be in compliance with Resolution MEPC.312(74) Guidelines for the use of electronic record books under MARPOL.

2.4 Sulphur Oxides

2.4.1 SOx limits (0,1 %)

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. In any case, the sulphur content of any fuel oil used on board ships is not to exceed the percentage by mass as required by MARPOL 73/78 Annex VI.

2.4.2 Gas to liquids (GTL) fuels

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].

2.4.3 Blending fossil fuel with second-generation bio-fuels

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 environ-

mental 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 blending [kW]

P_{TOT} = Nominal power of each user independently from the utilized fuel [kW]

2.4.4 Dual-fuel engines running with LNG

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.

2.4.5 Exhaust gas treatment

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 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 1, [8] as applicable.

Depending on installation a weighted index may be necessary.

2.4.6 SOx emissions monitoring and recording

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 1, [8] as applicable.

2.4.7 Electronic Fuel Oil Changeover Record Book (1/1/2020)

In order to avoid any data oversight due to manual input errors and to increase data integrity and accuracy, the Fuel Oil Changeover Record Book as required by MARPOL Annex VI, regulation 14.6, is to be replaced by an electronic record book. An anti-tampering mechanism is to be implemented in the system and each action is to be confirmed by a signature based on user's credentials and biometric details (i.e. fingerprint). The system is to be approved by Flag Administration.

The electronic record book is to be in compliance with Resolution MEPC.312(74) "Guidelines for the use of electronic record books under MARPOL".

2.5 Particulates

2.5.1 Gas to liquids (GTL) fuels

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 Regulation 13 of MARPOL Annex VI, are not to be taken into account.

2.5.2 Fuel treatment

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 1, 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.

2.5.3 Lower PMs emission achieved by modifications in prime movers (e.g. common rail) that do not increase other pollutants and GHGs emissions

Where modification in prime movers are carried out, to achieve lower PMs emission without increasing other pollutant and GHG emissions, only partially, the environmental index in Sec 1, 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.

2.5.4 Dual-fuel engines running with LNG

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.

2.5.5 Exhaust gas treatment

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 1, [8] as applicable.

Depending on installation a weighted index may be necessary.

2.6 Carbon Dioxide (CO₂)

2.6.1 Gas to liquids (GTL) fuels

Where GTL fuels are partially or totally used on board for CO₂ reduction, the environmental index in Sec 1, Tab 2 is weighted multiplying by R, defined as follows:

$$R = \frac{\sum P_{GTL}}{\sum P_{TOT}}$$

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 Blending fossil fuel with second-generation bio-fuels

Where blending (of fossil fuel and second generation bio-fuels) are partially or totally used on board for CO₂ reduction, the environmental index in Sec 1, Tab 2 is weighted multiplying by R, defined as follows:

$$R = \frac{\sum P_{sgbf}}{\sum P_{TOT}}$$

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]

2.6.3 Dual-fuel engines running with LNG

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.

2.6.4 CO emissions monitoring and recording

The ship is to be fitted with system for monitoring and recording the CO₂ 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 1, [8] as applicable.

2.6.5 Energy Efficiency Design Index (EEDI) (1/1/2020)

The ship is to be provided with an index measuring ship's CO₂ efficiency at the design stage, expressed in the form of CO₂ emitted per unit of transport work ("attained EEDI").

Taking into account the need to substantiate all data used in the EEDI formula, these requirements are mainly applicable to new buildings.

The "attained EEDI" is to be not greater than a "required EEDI" as described in Table 1, Regulation 21 of Resolution MEPC.203(62).

The "attained EEDI" is to be calculated according to the "2018 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI) for new ships" as per Resolution MEPC.308(73) as amended.

The "required EEDI" is to be calculated according to Regulation 21 of Marpol Annex VI.

Reference lines to be used for the calculation of the "required EEDI" are those contained in in Table 2, Regulation 21 of Marpol Annex VI.

The "attained EEDI" is to be calculated only for the types of ships which fall into one or more of the categories in Marpol Annex VI.

2.7 Noise

2.7.1 Noise level assessment and implementation of noise mitigation measures

For sea-going ships, an underwater noise assessment 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.

For ships operating at a fixed location, the assessment is to be carried out on both ambient and underwater noise to include:

- description of the noise levels existing in the area where the ship operates
- description of the sensitive receptors existing in the area, which may be affected by noise associated to the ship
- identification of significant noise levels and the measures for minimizing them. The noise abatement measures can include planning activities, appropriate selection of equipment, etc.
- the expected improvement in terms of noise impact and disturbance to terrestrial and marine species, including migrant animals.

Countermeasures are to be adopted for mitigating noise levels identified as significant.

Noise measurements assessing the effectiveness of the implemented measures are to be carried out annually.

The ambient and 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.

2.8 Visual intrusion

2.8.1 Visual impact assessment and implementation of the aesthetic mitigation measures (1/1/2020)

Visual impact assessment and implementation of the aesthetic mitigation measures are applicable only to ships intended to operate at a fixed location.

Visual impact assessment refers to a systematic analysis of potential impacts to landscape and waterscape resulting from the ship and relevant mooring systems located in a fixed position.

Visual impact assessment is also to include an investigation of the means available to mitigate the effects of such installations prior to their implementation.

There is no single precise methodology for visual impact assessment and is assessed largely by qualitative judgements, however the ship is to be provided with this assessment and identified mitigation measures are to be implemented.

The visual impact assessment is to be submitted to Society for information.

Score will be automatically recognized to ships with the additional class notation DOLPHIN QUIET SHIP and DOLPHIN TRANSIT SHIP.

2.8.2 Light pollution assessment and mitigation

Light pollution assessment and mitigation is applicable only to ships intended to operate at a fixed location.

The ship is to be provided with a specific 'illumination plan', to be developed at the detailed design stage, and a study on light pollution, including assessment on birds (migrant birds) and marine fauna, identification of effects and their mitigation.

Countermeasures are to be adopted for mitigating light pollution effects identified as significant.

The study is to address at least the following:

- species-dependent differences in light perception
- light intensity, wavelength, glow, elevation and directivity
- identification of minimum light needs (each light source is to be described in terms of its purpose, location, footprint, intensity and spectral composition).

Possible mitigation actions could be:

- lights off when not needed
- mount lights low down with lowest intensity for the job
- stop all light escaping upwards and outwards by means of appropriate shields
- use wavelength lights having minimum impact for the species involved.

The light pollution assessment is to be submitted to the Society for information.

2.9 Assessment and monitoring

2.9.1 Environmental Risk Assessment (ERA)

The ERA is applicable only to ships intended to operate at a fixed location.

An assessment of risk to the environment (air, water, land, plants and wildlife, including migrant animals) is to be carried out for the area and the surroundings where the ships operate.

The assessment is to be made according to the following steps:

- Hazard identification
- Identification of consequences if the hazard was to occur
- Identification of existing controls
- Estimation of the magnitude of the consequences, considering the existing controls
- Estimation of the probability of the consequences, considering the existing controls
- Evaluation of the risk.

The assessment is to consider operative and emergency conditions.

Software tools may be used for the estimation of magnitude and probability of the consequences, for example software for the evaluation of a toxic release.

Designers are free to choose any methodology for the evaluation of risk.

The outcome is to be the identification of the necessary measures to eliminate or, if not possible, minimize the risks identified.

The measures are to be adopted.

The ERA is to be periodically reviewed (in agreement with the Society) in order to assess the efficiency of the measures and the changes occurred in the meantime.

The ERA and the successive reviews are to be submitted to the Society for information.

2.9.2 Annual monitoring of air quality

These monitoring activities are applicable only to ships intended to operate at a fixed location.

An annual monitoring plan of air quality is to be implemented and maintained in the time.

The plan, the list of parameters to be monitored and the sampling points are to be agreed with an expert (Environmental Protection Agency or chemist or equivalent) taking into account the environmental sensitivities and the cargo.

The equipment used for monitoring purposes is to be properly calibrated and maintained.

Monitoring data are to be analyzed by an expert so that any necessary corrective actions can be taken.

A first monitoring activity is to be performed prior to the assignment of the score relevant to this item.

2.9.3 Annual monitoring of seawater quality

These monitoring activities are applicable only to ships intended to operate at a fixed location.

An annual monitoring plan of seawater quality is to be implemented and maintained.

The plan, the list of parameters to be monitored and the sampling points are to be agreed with an expert (Environmental Protection Agency or marine biologist or equivalent) taking into account the environmental sensitivities, assimilative capacity of seawater and the type of cargo.

BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), pH, oil, total dissolved solids are to be monitored.

The equipment used for monitoring purposes is to be properly calibrated and maintained.

Monitoring data are to be analysed by experts so that any necessary corrective actions can be taken.

A first monitoring activity is to be performed prior to the assignment of the score relevant to this item.

2.9.4 Annual monitoring of terrestrial and marine flora

These monitoring activities are applicable only to ships intended to operate at a fixed location.

An annual monitoring plan of terrestrial and marine flora is to be implemented and maintained.

The plan, the list of parameters to be monitored and the sampling points are to be agreed with an expert (Environmental Protection Agency or biologist or equivalent) taking into account the type of cargo and the terrestrial and marine flora present in the area.

The equipment used is to be properly calibrated and maintained.

Monitoring data is to be analysed by experts so that any necessary corrective actions can be taken.

A first monitoring activity is to be performed prior the assignment of the score relevant to this item.

2.9.5 Annual monitoring of terrestrial and marine fauna, including migrant animals

These monitoring activities are applicable only to ships intended to operate at a fixed location.

An annual monitoring plan of terrestrial and marine fauna, including migrant animals, is to be implemented and maintained in the time.

The plan, the list of parameters to be monitored and the sampling points are to be agreed with an expert (Environ-

mental Protection Agency or biologist or equivalent) taking into account the type of cargo and the terrestrial and marine fauna, including migrant animals, present in every period of the year in the area.

The equipment used is to be properly calibrated and maintained.

Monitoring data are to be analysed by experts so that any necessary corrective actions can be taken.

A first monitoring activity is to be performed prior to the assignment of the score relevant to this item.

2.9.6 Periodic ambient and underwater noise monitoring and recording

These monitoring activities are applicable only to ships intended to operate at a fixed location.

An annual monitoring plan of ambient and underwater noise is to be implemented and maintained.

The plan and the sampling points are to be agreed with the Society.

The equipment used is to be properly calibrated and maintained.

The measurements are to be conducted in accordance with international standards.

Monitoring data are to be analysed by experts so that any necessary corrective actions can be taken.

A first monitoring activity is to be performed prior to the assignment of the score relevant to this item.

2.10 Ship at scrap

2.10.1 Ship recycling - HK Inventory of Hazardous Materials (HK IHM) (1/1/2020)

The ship is to comply with the requirements of Sec 4, [2.7] and is to be provided with an Inventory of Hazardous Materials.

The HK Inventory of Hazardous Materials is to be developed according to IMO Resolution MEPC.269(68) "2015 Guidelines for the development of the inventory of hazardous materials".

In application of the requirements of the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009, the HK IHM provides detailed information with regard to potentially hazardous materials utilized in the construction of the ship, its equipment and systems.

This document accompanies the ship throughout its operating life and incorporates all relevant design and equipment changes, with the final Owner delivering the document, with the ship, to the recycling facility.

2.10.2 Ship recycling - EU Inventory of Hazardous Materials (EU IHM) (1/1/2020)

The EU Inventory of Hazardous Materials is to be developed according to EU Ship Recycling Regulation n° 1257/2013 on ship recycling and relevant EMSA guidelines.

3 Procedures

3.1

3.1.1

The Ship Environmental Management Plan, referred to in Sec 1, [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;
- 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;
- spillage during bunkering;
- periodical checks of the overflow systems/alarms;
- preparation, filling in and maintenance of the cargo record book (for ships carrying noxious liquid substances in bulk);
- 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 treat-

ment 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.

APPENDIX 3

STANDARDS SPECIFICATIONS FOR SHIPBOARD INCINERATORS

(IMO RESOLUTION MEPC.76(40) ADOPTED ON 25 SEPTEMBER 1997)

1 General

1.1 Scope

1.1.1 Coverage

This specification covers the design, manufacture, performance, operation and testing of incinerators intended to incinerate garbage and other shipboard wastes generated during the ship's normal service.

1.1.2 Application

This specification applies to those incinerator plants with capacities up to 1500 kW per unit.

1.1.3 Industrial systems

This specification does not apply to systems on special incinerator ships, e.g. for burning industrial wastes such as chemicals, manufacturing residues, etc.

1.1.4 Items not addressed by the specification

This specification does not address the electrical supply to the unit or the foundation connections and stack connections.

1.1.5 Emission requirements

This specification provides emission requirements in Annex A1 and fire protection requirements in Annex A2. Provisions for incinerators integrated with heat recovery units and provisions for flue gas temperature are given in Annex A3 and Annex A4, respectively.

1.1.6 Hazardous materials

This specification may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use, including possible port State limitations.

1.2 Definitions

1.2.1 Ship

Ship means a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushioned vehicles, submersibles, floating craft and fixed or floating platforms.

1.2.2 Incinerator

Incinerator means shipboard facilities for incinerating solid wastes approximating in composition to household waste

and liquid wastes arising from the operation of the ship, e.g. domestic waste, cargo-associated waste, maintenance waste, operational waste, cargo residues and fishing gear, etc. These facilities may be designed to use or not to use the heat energy produced.

1.2.3 Garbage

Garbage means all kinds of victual, domestic and operational waste excluding fresh fish and parts thereof, generated during normal operation of the ship as defined in Annex V to MARPOL 73/78.

1.2.4 Waste

Waste means useless, unneeded or superfluous matter which is to be discarded.

1.2.5 Food wastes

Food wastes are any spoiled or unspoiled victual substances, such as fruits, vegetables, dairy products, poultry, meat products, food scraps, food particles, and all other materials contaminated by such wastes, generated aboard ship, principally in the galley and dining areas.

1.2.6 Plastic

Plastic means a solid material which contains as an essential ingredient one or more synthetic organic high polymers and which is formed (shaped) during either manufacture of the polymer or the fabrication into a finished product by heat and/or pressure. Plastics have material properties ranging from hard and brittle to soft and elastic. Plastics are used for a variety of marine purposes including, but not limited to, packaging (vapour-proof barriers, bottles, containers, liners), ship construction (fibreglass and laminated structures, siding, piping, insulation, flooring, carpets, fabrics, paints and finishes, adhesives, electrical and electronic components), disposable eating utensils and cups, bags, sheeting, floats, fishing nets, strapping bands, rope and line.

1.2.7 Domestic waste

Domestic waste means all types of food wastes, sewage and wastes generated in the living spaces on board the ship for the purpose of this specification.

1.2.8 Cargo-associated waste

Cargo-associated waste means all materials which have become wastes as a result of use on board a ship for cargo stowage and handling. Cargo-associated waste includes but is not limited to dunnage, shoring pallets, lining and packing materials, plywood, paper, cardboard, wire, and steel strapping.

1.2.9 Maintenance waste

Maintenance waste means materials collected by the engine department and the deck department while maintaining and operating the vessel, such as soot, machinery deposits, scraped paint, deck sweeping, wiping wastes, oily rags, etc.

1.2.10 Operational waste

Operational wastes means all cargo-associated wastes and maintenance waste (including ash and clinkers), and cargo residues defined as garbage in Sec 4, [1.3.6].

1.2.11 Sludge oil

Sludge oil means sludge from fuel and lubricating oil separators, waste lubricating oil from main and auxiliary machinery and waste oil from bilge water separators, drip trays, etc.

1.2.12 Oily rags

Oily rags are rags which have been saturated with oil as provided for in Annex I to the Convention. Contaminated rags are rags which have been saturated with a substance defined as a harmful substance in the other annexes to MARPOL 73/78.

1.2.13 Cargo residues

Cargo residues for the purposes of this standard are defined as the remnants of any cargo material on board that cannot be placed in proper cargo holds (loading excess and spillage) or which remains in cargo holds and elsewhere after unloading procedures are completed (unloading residual and spillage). However, cargo residues are expected to be in small quantities.

1.2.14 Fishing gear

Fishing gear is defined as any physical device or part thereof or combination of items that may be placed on or in the water with the intended purpose of capturing, or controlling for subsequent capture, living marine or freshwater organisms.

2 Design

2.1 Materials and manufacture

2.1.1 Materials

The materials used in the individual parts of the incinerator are to be suitable for the intended application with respect to heat resistance, mechanical properties, oxidation, corrosion, etc., as in other auxiliary marine equipment.

2.1.2 Piping

Piping for fuel and sludge oil should be seamless steel of adequate strength and to the satisfaction of the Society. Short lengths of steel, or annealed copper nickel, nickel copper, or copper pipe and tubing may be used for the burners. The use of non-metallic materials for fuel lines is prohibited. Valves and fittings may be threaded in sizes up to and including 60 mm O.D. (outside diameter), but threaded unions are not to be used on pressure lines in sizes 33 mm O.D. (outside diameter) and over.

2.1.3 Protection of rotating parts

All rotating or moving mechanical and exposed electrical parts should be protected against accidental contact.

2.1.4 Incinerator wall protection

Incinerator walls are to be protected with insulated fire bricks/refractory and a cooling system. Outside surface temperature of the incinerator casing which may be touched during normal operations should not exceed 20°C above ambient temperature.

2.1.5 Refractory design and material

Refractory should be resistant to thermal shocks and to normal ship's vibration. The refractory design temperature should be equal to the combustion chamber design temperature plus 20%. (See [2.1])

2.1.6 Corrosion minimisation

Incinerating systems should be designed such that corrosion will be minimised on the inside of the systems.

2.1.7 Incinerators equipped to incinerate liquid waste

In systems equipped for incinerating liquid wastes, safe ignition and maintenance of combustion are to be ensured, e.g. by a supplementary burner using gas oil/diesel oil or equivalent.

2.1.8 Combustion chamber design

The combustion chamber(s) should be designed for easy maintenance of all internal parts including the refractory and insulation.

2.1.9 Means to assure negative pressure in the furnace

The combustion process should take place under negative pressure which means that the pressure in the furnace under all circumstances should be lower than the ambient pressure in the room where the incinerator is installed. A flue gas fan may be fitted to secure negative pressure.

2.1.10 Incinerator furnace charging

The incinerating furnace may be charged with solid waste either by hand or automatically. In every case, fire dangers should be avoided and charging should be possible without danger to the operating personnel. For instance, where charging is carried out by hand, a charging lock may be provided which ensures that the charging space is isolated from the fire box as long as the filling hatch is open. Where charging is not effected through a charging lock, an interlock should be installed to prevent the charging door from opening while the incinerator is in operation with burning of garbage in progress or while the furnace temperature is above 220 °C.

2.1.11 Incinerators equipped with feeding sluice

Incinerators equipped with a feeding sluice or system should ensure that the material charged will move to the combustion chamber. Such system should be designed such that both operator and environment are protected from hazardous exposure.

2.1.12 Interlocks

Interlocks should be installed to prevent ash removal doors from opening while burning is in progress or while the furnace temperature is above 220 °C.

2.1.13 Observation ports

The incinerator should be provided with a safe observation port of the combustion chamber in order to provide visual control of the burning process and waste accumulation in the combustion chamber. Neither heat, flame nor particles should be able to pass through the observation port. An example of a safe observation port is high-temperature glass with a metal closure.

2.1.14 Electrical requirements

a) Electrical installation requirements should apply to all electrical equipment, including controls, safety devices, cables, and burners and incinerators.

- 1) A disconnecting means capable of being locked in the open position should be installed at an accessible location at the incinerator so that the incinerator can be disconnected from all sources of potential. This disconnecting means should be an integral part of the incinerator or adjacent to it. (See [2.3.1])
- 2) All uninsulated live metal parts should be guarded to avoid accidental contact.
- 3) The electrical equipment should be arranged so that failure of this equipment will cause the fuel supply to be shut off.
- 4) All electrical contacts of every safety device installed in the control circuit should be electrically connected in series. However, special consideration should be given to arrangements when certain devices are wired in parallel.
- 5) All electrical components and devices should have a voltage rating commensurate with the supply voltage of the control system.
- 6) All electrical devices and electrical equipment exposed to the weather should meet the requirements of international standards acceptable to the Society.
- 7) All electrical and mechanical control devices should be of a type tested and accepted by a nationally recognised testing agency, according to international standards.
- 8) The design of the control circuits should be such that limit and primary safety controls directly open a circuit that functions to interrupt the supply of fuel to combustion units.

b) Overcurrent protection

- 1) Conductors for interconnecting wiring that is smaller than the supply conductors should be provided with overcurrent protection based on the size of the smallest interconnecting conductors external to any control box, in accordance with the requirements of acceptable international standards.
- 2) Overcurrent protection for interconnecting wiring should be located at the point where the smaller conductors connect to the larger conductors. How-

ever, overall overcurrent protection is acceptable if it is sized on the basis of the smallest conductors of the interconnecting wiring, or in accordance with the requirements of acceptable international standards.

- 3) Overcurrent protection devices should be accessible and their function should be identified.

c) Motors

- 1) All electric motors should have enclosures corresponding to the environment where they are located, at least IP 44, in accordance with the requirements of international standards acceptable to the Society.
- 2) Motors should be provided with a corrosion-resistant nameplate specifying information in accordance with the requirements of acceptable international standards.
- 3) Motors should be provided with running protection by means of integral thermal protection, overcurrent devices, or a combination of both in accordance with the Manufacturer's instructions and with the requirements of acceptable international standards.
- 4) Motors should be rated for continuous duty and designed for an ambient temperature of 45 °C or higher.
- 5) All motors should be provided with terminal leads or terminal screws in terminal boxes integral with, or secured to, the motor frames.

d) Ignition system

- 1) When automatic electric ignition is provided, it should be accomplished by means of either a high voltage electric spark, a high energy electric spark, or a glow coil.
- 2) Ignition transformers should have an enclosure corresponding to the environment where they are located, at least IP 44, in accordance with the requirements of acceptable international standards.
- 3) Ignition cable should meet the requirements of acceptable international standards.

e) Wiring

- 1) All wiring for incinerators should be rated and selected in accordance with the requirements of acceptable international standards.

f) Bonding and grounding

- 1) Means should be provided for grounding the major metallic frame or assembly of the incinerator.
- 2) Non-current carrying enclosures, frames and similar parts of all electrical components and devices should be bonded to the main frame or assembly of the incinerator. Electrical components that are bonded by their installation do not require a separate bonding conductor.
- 3) When an insulated conductor is used to bond electrical components and devices, it should show a continuous green colour, with or without a yellow stripe.

2.2 Operating requirements

2.2.1 Design operating conditions

The incinerator system should be designed and constructed for operation with the following conditions, as indicated in Tab 1 and Tab 2:

Table 1

Item	Temperature
Maximum combustion chamber flue gas outlet temperature	1200 °C
Minimum combustion chamber flue gas outlet temperature	850 °C
Preheat temperature of combustion chamber	650 °C

For batch loaded incinerators there are no preheating requirements. However, the incinerator should be designed such that the temperature in the actual combustion space reaches 600°C within 5 minutes after start.

Table 2

Operation	Mode
Prepurge, before ignition	At least 4 air changes in the chamber(s) and stack, but not less than 15 seconds.
Time between restarts	At least 4 air changes in the chamber(s) and stack, but not less than 15 seconds.
Postpurge, after shut-off of fuel oil	Not less than 15 seconds after the closing of the fuel oil valve.
Incinerator discharge gases	Minimum 6% O ₂ (measured in dry flue gas)

2.2.2 Shielding of combustion chamber surfaces

The outside surface of combustion chamber(s) should be shielded from contact such that people in normal work situations will not be exposed to extreme heat (20°C above ambient temperature) or direct contact with surface temperatures exceeding 60°C. Examples for alternatives to accomplish this are a double jacket with an air flow in between or an expanded metal jacket.

2.2.3 Operating pressure

Incinerating systems are to be operated with underpressure (negative pressure) in the combustion chamber such that no gases or smoke can leak out to the surrounding areas.

2.2.4 Warning plates

The incinerator should have warning plates attached in a prominent location on the unit, warning against unauthorised opening of doors to combustion chamber(s) during operation and against overloading the incinerator with garbage.

2.2.5 Instruction plate

The incinerator should have instruction plate(s) attached in a prominent location on the unit clearly addressing the following:

- Cleaning ashes and slag from the combustion chamber(s) and cleaning of combustion air openings before starting the incinerator (where applicable).
- Operating procedures and instructions. These should include proper start-up procedures, normal shutdown procedures, emergency shutdown procedures and procedures for loading garbage (where applicable).

2.2.6 Prevention of building up of dioxins

To avoid building up of dioxins, the flue gas should be shock-cooled to a maximum 350 °C within 2,5 metres from the combustion chamber flue gas outlet.

2.3 Operating controls

2.3.1 Disconnecting switch

The entire unit should be capable of being disconnected from all sources of electricity by means of one disconnect switch located near the incinerator (see [2.1.14] a) 1)).

2.3.2 Emergency stop

There should be an emergency stop switch located outside the compartment which stops all power to the equipment. The emergency stop switch should also be able to stop all power to the fuel pumps. If the incinerator is equipped with a flue gas fan, the fan should be capable of being restarted independently of the other equipment on the incinerator.

2.3.3 Control equipment design

The control equipment should be so designed that any failure of the following will prevent continued operations and cause the fuel supply to be cut off.

- Safety thermostat/draft failure
 - A flue gas temperature controller, with a sensor placed in the flue gas duct, should be provided to shut down the burner if the flue gas temperature exceeds the temperature set by the Manufacturer for the specific design.
 - A combustion temperature controller, with a sensor placed in the combustion chamber, should be provided to shut down the burner if the combustion chamber temperature exceeds the maximum temperature.
 - A negative pressure switch should be provided to monitor the draft and the negative pressure in the combustion chamber. The purpose of this negative pressure switch is to ensure that there is sufficient draft/negative pressure in the incinerator during operations. The circuit to the program relay for the burner will be opened and an alarm activated before the negative pressure rises to atmospheric pressure.
- Flame failure/fuel oil pressure
 - The incinerator should have a flame safeguard control consisting of a flame sensing element and associated equipment for shutdown of the unit in the event of ignition failure and flame failure during the

firing cycle. The flame safeguard control should be so designed that the failure of any component will cause a safety shutdown.

- 2) The flame safeguard control should be capable of closing the fuel valves in not more than 4 seconds after a flame failure.
 - 3) The flame safeguard control should provide a trial-for-ignition period of not more than 10 seconds during which fuel may be supplied to establish flame. If flame is not established within 10 seconds, the fuel supply to the burners should be immediately shut off automatically.
 - 4) Whenever the flame safeguard control has operated because of failure of ignition, flame failure or failure of any component, only one automatic restart may be provided. If this is not successful, then manual reset of the flame safeguard control should be required for restart.
 - 5) Flame safeguard controls of the thermostatic type, such as stack switches and pyrostats operated by means of an open bimetallic helix, are prohibited.
 - 6) If fuel oil pressure drops below the value set by the Manufacturer, a failure and lock out of the program relay should result. This also applies to a sludge oil burner (where pressure is important for the combustion process or a pump is not an integral part of the burner.)
- c) Loss of power
- 1) If there is a loss of power to the incinerator control/alarm panel (not remote alarm panel), the system should shut down.

2.3.4 Fuel control solenoid valves

Two fuel control solenoid valves should be provided in series in the fuel supply line to each burner. On multiple burner units, a valve on the main fuel supply line and a valve at each burner will satisfy this requirement. The valves should be connected electrically in parallel so that both operate simultaneously.

2.3.5 Alarms

- a) An outlet for an audible alarm should be provided for connection to a local alarm system or a central alarm system. When a failure occurs, a visible indicator should show what caused the failure. (The indicator may cover more than one fault condition.)
- b) The visible indicator should be designed so that, where failure is a safety related shutdown, manual reset is required.

2.3.6 Cooling after shutdown

After shutdown of the oil burner, provision should be made for the fire box to cool sufficiently. (As an example of how this may be accomplished, the exhaust fan or ejector could be designed to continue to operate. This would not apply in the case of an emergency manual trip).

2.4 Other requirements

2.4.1 Documentation

A complete instruction and maintenance manual with drawings, electrical diagrams, spare parts list, etc. should be furnished with each incinerator.

2.4.2 Installation

All devices and components should, as fitted in the ship, be designed to operate when the ship is upright and when inclined at any angle of list up to and including 15° either way under static conditions and 22,5° under dynamic conditions (rolling) either way and simultaneously inclined dynamically (pitching) 7,5° by bow or stern.

2.4.3 Incinerators

- a) Incinerators are to be fitted with an energy source with sufficient energy to ensure a safe ignition and complete combustion. The combustion is to take place at sufficient negative pressure in the combustion chamber(s) to ensure that no gases or smoke leak out to the surrounding areas.
- b) A drip tray is to be fitted under each burner and under any pumps, strainers, etc. that require occasional examination.

3 Tests and certification

3.1 Tests

3.1.1 Prototype tests

An operating test for the prototype of each design should be conducted, with a test report completed indicating results of all tests. The tests should be conducted to ensure that all of the control components have been properly installed and that all parts of the incinerator, including controls and safety devices, are in satisfactory operating condition. Tests should include those described in [3.1.3] below.

3.1.2 Factory tests

For each unit, if preassembled, an operating test should be conducted to ensure that all of the control components have been properly installed and that all parts of the incinerator, including controls and safety devices, are in satisfactory operating condition. Tests should include those described in [3.1.3] below.

3.1.3 Shipboard tests

An operating test after installation should be conducted to ensure that all of the control components have been properly installed and that all parts of the incinerator, including controls and safety devices, are in satisfactory operating condition. The requirements for prepurge and time between restarts should be verified at the time of the installation test.

a) Flame safeguard

The operation of the flame safeguard system should be verified by causing flame and ignition failures. Operation of the audible alarm (where applicable) and visible indicator should be verified. The shutdown times should be verified.

- b) Limit controls
Shutdown due to the operation of the limit controls should be verified.
- 1) Oil pressure limit control
The lowering of the fuel oil pressure below the value required for safe combustion should initiate a safety shutdown.
 - 2) Other interlocks
Other interlocks provided should be tested for proper operation as specified by the unit Manufacturer.
- c) Combustion controls
The combustion controls should be stable and operate smoothly.
- d) Programming controls
Programming controls should be verified as controlling and cycling the unit in the intended manner. Proper prepurge, ignition, postpurge and modulation should be verified. A stopwatch should be used for verifying intervals of time.
- e) Fuel supply controls
The satisfactory operation of the two fuel control solenoid valves for all conditions of operation and shutdown should be verified.
- f) Low voltage test
A low voltage test should be conducted on the incinerator unit to satisfactorily demonstrate that the fuel supply to the burners will be automatically shut off before an incinerator malfunction results from the reduced voltage.
- g) Switches
All switches should be tested to verify proper operation.

3.2 Certification

3.2.1 The Manufacturer's certification that an incinerator has been constructed in accordance with this standard should be provided (by letter, certificate or in the instruction manual).

3.3 Marking

3.3.1 Each incinerator should be permanently marked indicating:

- a) Manufacturer's name or trademark
- b) Style, type, model or other Manufacturer's designation for the incinerator
- c) Capacity - to be indicated by net designed heat release of the incinerator in heat units per timed period; for example, British Thermal Units per hour, megajoules per hour, kilocalories per hour.

3.4 Quality assurance

3.4.1 Incinerators should be designed, manufactured and tested in a manner that ensures they meet the requirements of this standard.

4 ANNEX A1 - Emission standard for shipboard incinerators with capacity of up to 1500 kW - Minimum information to be provided

4.1 IMO Type Approval Certificate

4.1.1 An IMO Type Approval Certificate should be required for each shipboard incinerator. In order to obtain such certificate, the incinerator should be designed and built to an IMO approved standard. Each model should go through a specified type approval test procedure at the factory or an approved test facility, and under the responsibility of the Society.

Note 1: The incinerator is to be of a type approved or accepted by the Society.

4.1.2 Type approval tests should include measuring of the parameters listed in Tab 3:

Table 3

Item	Measure
Max Capacity	kW or kcal/h kg/h of specified waste kg/h per burner
Pilot fuel consumption	kg/h per burner
O ₂ Average in combustion chamber/zone	%
CO Average in flue gas	mg/MJ
Soot number average	Bacharach or Ringelman Scale
Combustion chamber flue gas outlet average temperature	°C
Amount of unburned components in ashes	% by weight

4.1.3 Tab 4 indicates the duration of test operations.

Table 4

Operation	Time
For sludge oil burning	6 - 8 hours
For solid waste burning	6 - 8 hours

4.1.4 Fuel test specifications for type approval tests (% by weight) are indicated in Tab 5 and Tab 6.

4.1.5 Tab 7 indicates the required emission standard to be verified by the type approval test.

Flue gas outlet temperature and O₂ content should be measured during the combustion period, and not during the pre-heating or cooling periods. For a batch loaded incinerator, it is acceptable to carry out the type approval test by means of a single batch.

A high temperature in the actual combustion chamber/zone is an absolute requirement in order to obtain a complete and smoke free incineration, including that of plastic and other synthetic materials, while minimising DIOXINE, VOC (Volatile Organic Compounds) and emissions.

Table 5

Sludge/waste	Specification
Sludge oil consisting of	75% sludge oil from heavy fuel oil 5% waste lubricating oil 20% emulsified water
Solid waste (class 2) consisting of	50% food waste 50% rubbish containing <ul style="list-style-type: none"> • approx 30% paper • approx 40% cardboard • approx 10% rags • approx 20% plastic The mixture will have up to 50% moisture and 7% incombustible solids
<p>Note 1: Classes of waste Reference: Waste Classification from Incinerator Institute of America (Information for type approval tests only)</p> <p>Note 2: Class 2 Refuse, consisting of approximately even mixture of rubbish and garbage by weight. This type of waste is common to passenger ships, consists of up to 50% moisture, 7% incombustible solids and has a heating value of about 10 000 kJ/kg as fired.</p>	

Table 6

Calorific values			Densities	
Sludge	kJ/Kg	kcal/kg Sludge		kg/m ³
Vegetables and putrescibles	5700	1360	Paper (loose)	50
Paper	14300	3415	Refuse (75% wet)	720
Rag	15500	3700	Dry rubbish	110
Plastics	36000	8600	Scrap wood	190
Sludge oil	36000	8600	Wood sawdust	220
Sewage sludge	3000	716		
Note 1: Density of loose general waste generated on board ship will be about 130 kg/m ³ .				

Table 7

Emission	Standard
O ₂ in combustion chamber	6 - 12%
CO in flue gas maximum average	200 mg/MJ
Soot number maximum average	BACHARACH 3 or RINGELMAN 1 (A higher soot number is acceptable only during very short periods such as starting up)
Unburned components in ash residues	Max 10% by weight
Combustion chamber flue gas outlet temperature range	850-1200 °C

4.2 Fuel related emission

4.2.1

- a) Even with good incineration technology the emission from an incinerator will depend on the type of material being incinerated. If for instance a vessel has bunkered a fuel with high sulphur content, then sludge oil from separators which is burned in the incinerator will lead to emission of SO_x. But again, the SO_x emission from the incinerator would only amount to less than one per cent of the SO_x discharged with the exhaust from main and auxiliary engines.
- b) Principal organic constituents (POC) cannot be measured on a continuous basis. Specifically, there are no instruments with provision for continuous time telemetry that measure POC, HCl or waste destruction efficiency, to date. These measurements can only be made using grab sample approaches where the sample is returned to a laboratory for analysis. In the case of organic constituents (undestroyed wastes), the laboratory work requires considerable time to complete. Thus, continuous emission control can only be assured by secondary measurements.
- c) ON BOARD OPERATION/EMISSION CONTROL

For a shipboard incinerator with IMO TYPE APPROVAL, emission control/monitoring should be limited to the following:

- 1) Control/monitor O₂ content in combustion chamber (spot checks only; an O₂ content analyser is not required to be on board).
- 2) Control/monitor temperature in combustion chamber flue gas outlet.

By continuous (auto) control of the incineration process, it is ensured that the two parameters mentioned above are kept within the prescribed limits. This mode of operation will ensure that particulates and ash residue contain only traces of organic constituents.

4.3 Passenger/cruise ships with incinerator installations having a total capacity of more than 1500 kW

4.3.1

- a) On board this type of vessel, the following conditions will probably exist:
- 1) Generation of huge amounts of burnable waste with a high content of plastic and synthetic materials.
 - 2) Incinerating plant with a high capacity operating continuously over long periods.
 - 3) Vessel often operating in very sensitive coastal areas.
- b) In view of the fuel related emission from a plant with such a high capacity, installation of a flue gas sea water scrubber should be considered. This installation can perform an efficient after-cleaning of the flue gases, thus minimising the content of:
- HC1

- SO_x
- PARTICULATE MATTER

- c) Any restriction on NITROGEN OXIDE (NO_x) should only be considered in connection with possible future regulations governing the vessel's total pollution, i.e. main and auxiliary machinery, boilers, etc.

5 ANNEX A2 - Fire protection requirements for incinerators and waste stowage spaces

5.1 SOLAS requirements to be applied

5.1.1 For the purpose of construction, arrangement and insulation, incinerator spaces and waste stowage spaces should be treated as category A machinery spaces (SOLAS II-2/3.19) and service spaces (SOLAS II-2/3.12), respectively. To minimise the fire hazards these spaces represent, the following SOLAS requirements in Chapter II-2 should be applied:

- a) Annex A2.1 - Passenger ships
For passenger vessels carrying more than 36 passengers
- 1) Regulation 26.2.2(12) should apply to incinerator and combined incinerator/waste stowage spaces, and the flue uptakes from such spaces
 - 2) Regulation 26.2.2(13) should apply to waste stowage spaces and garbage chutes connected thereto.
- b) Annex A2.2 - Other ships
For all other vessels, including passenger vessels carrying not more than 36 passengers:
- 1) Regulation 44.2.2(6) should apply to incinerator and combined incinerator/waste spaces, and the flue uptakes from such spaces
 - 2) Regulation 44.2.2(9) should apply to waste stowage spaces and garbage chutes connected thereto.
- c) Annex A2.3 - Incinerators and waste stowage spaces
Incinerators and waste stowage spaces located on weather decks (Regulation II-2/3.(17)) need not meet the above requirements but should be located:
- 1) as far aft on the vessel as possible;
 - 2) not less than 3 m from entrances, air inlets and openings to accommodation and service spaces and control stations;
 - 3) not less than 5 m measured horizontally from the nearest hazardous area, or vent outlet from a hazardous area; and
 - 4) not less than 2 m from the incinerator and the waste material stowage area, unless physically separated by a structural fire barrier.
- d) Annex A2.4 - Fixed fire-extinguishing and fire detection system
A fixed fire detection and fire-extinguishing system should be installed in enclosed spaces containing incinerators, in combined incinerator/waste stowage spaces, and in any waste stowage space in accordance with Tab 8.

- e) Annex A2.5 - Incinerator and waste stowage spaces on weather decks

Where an incinerator or waste stowage space is located on weather decks it must be accessible with two means of fire extinguishment: either fire hoses, semi-portable fire extinguishers, fire monitors or a combination of any two of these extinguishing devices. A fixed fire-extinguishing system is acceptable as one means of extinguishment.

- f) Annex A2.6 - Flue uptakes

Flue uptake piping/ducting should be led independently to an appropriate terminus via a continuous funnel or trunk.

6 ANNEX A3 - Incinerators integrated with heat recovery units

6.1 Flue gas system

6.1.1 The flue gas system, for incinerators where the flue gas is led through a heat recovery device, should be designed so that the incinerator can continue operation with the economiser coils dry. This may be accomplished with bypass dampers if needed.

6.2 Alarms

6.2.1 The incinerator unit should be equipped with a visual and an audible alarm in case of loss of feed water.

6.3 Cleaning devices

6.3.1 The gas-side of the heat recovery device should have equipment for proper cleaning. Sufficient access should be provided for adequate inspection of external heating surfaces.

7 ANNEX A4 - Flue gas temperature

7.1 General

7.1.1 When deciding upon the type of incinerator, consideration should be given as to what the flue gas temperature will be. The flue gas temperature can be a determining factor in the selection of materials for fabricating the stack. Special high temperature material may be required for use in fabricating the stack when the flue gas temperature exceeds 430 °C.

Table 8

	Automatic sprinkler system	Fixed fire-extinguishing system	Fixed fire detection system
Combined incinerator and waste stowage space	X		
Incinerator space		X	X
Waste stowage space	X		