Rules for the Classification of Steel Ships

NR 467

AMENDMENTS

January 2016

These sheets contain amendments within the following Sections of July 2014 issue of the *Rules for the Classification of Steel Ships*.

These amendments are cumulative with:

- Amendments January 2015
- Amendments July 2015

These amendments are effective from January 1st, 2016.

Part	Volume	Chapter	Section / Appendix
Part A	*NR 467 A1 DT R12 E*	Ch 1	Sec 1, Sec 2
		Ch 2	Sec 1, Sec 2, App 2
		Ch 3	Sec 1, Sec 4, Sec 5, Sec 6, Sec 7, App 1
		Ch 4	Sec 1, Sec 2, Sec 3, Sec 4, Sec 8
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MARINE & OFFSHORE DIVISION
GENERAL CONDITIONS

ARTICLE 1

1.1. - BUREAU VERITAS is a Society the purpose of whose Marine & Offshore Division (the "Society") is the classification (" Classification ") of any ship or vessel or offshore unit or structure of any type or part of it or system therein collectively hereinafter referred to as a "Unit" whether linked to shore, river bed or sea bed or not, whether operated or located at sea or in inland waters or partly on land, including submarines, hovercrafts, drilling rigs, offshore installations of any type and of any purpose, their related and ancillary equipment, subsea or not, such as well head and pipelines, mooring legs and mooring points or otherwise as decided by the Society.

The Society:

- "prepares and publishes Rules for classification, Guidance Notes and other documents (" Rules ");
- "issues Certificates, Attestations and Reports following its interventions (" Certificates ");
- "publishes Registers.

1.2. - The Society also participates in the application of National and International Regulations or Standards, in particular by delegation from different Governments. Those activities are hereafter collectively referred to as " Certification ".

1.3. - The Society can also provide services related to Classification and Certification such as ship and company safety management certification; ship and port security certification, training activities; all activities and duties incidental thereto such as documentation on any supporting means, software, instrumentation, measurements, tests and trials on board.

1.4. - The interventions mentioned in 1.1., 1.2. and 1.3. are referred to as " Services ". The party and/or its representative requesting the services is hereinafter referred to as the " Client ". **The Services are prepared and carried out on the assumption that the Clients are aware of the International Maritime and/or Offshore Industry (the "Industry") practices.**

1.5. - The Society is neither and may not be considered as an Underwriter, Broker in ship's sale or chartering, Expert in Unit's valuation, Consulting Engineer, Controller, Naval Architect, Manufacturer, Shipbuilder, Repair yard, Charterer or Shipowner who are not relieved of any of their expressed or implied obligations by the interventions of the Society.

ARTICLE 2

2.1. - Classification is the appraisement given by the Society for its Client, at a certain date, following surveys by its Surveyors along the lines specified in Articles 3 and 4 hereafter on the level of compliance of a Unit to its Rules or part of them. This appraisement is represented by a class entered on the Certificates and periodically transcribed in the Society's Register.

2.2. - Certification is carried out by the Society along the same lines as set out in Articles 3 and 4 hereafter and with reference to the applicable National and International Regulations or Standards.

2.3. - **It is incumbent upon the Client to maintain the condition of the Unit after surveys, to present the Unit for surveys and to inform the Society without delay of circumstances which may affect the given appraisement or cause to modify its scope.**

2.4. - The Client is to give to the Society all access and information necessary for the safe and efficient performance of the requested Services. The Client is the sole responsible for the conditions of presentation of the Unit for tests, trials and surveys and the conditions under which tests and trials are carried out.

ARTICLE 3

3.1. - **The Rules, procedures and instructions of the Society take into account at the date of their preparation the state of currently available and proven technical knowledge of the Industry. They are a collection of minimum requirements but not a standard or a code of construction neither a guide for maintenance, a safety handbook or a guide of professional practices, all of which are assumed to be known in detail and carefully followed at all times by the Client.**

Committees consisting of personalities from the Industry contribute to the development of those documents.

3.2. - **The Society only is qualified to apply its Rules and to interpret them. Any reference to them has no effect unless it involves the Society's intervention.**

3.3. - The Services of the Society are carried out by professional Surveyors according to the applicable Rules and to the Code of Ethics of the Society. Surveyors have authority to decide locally on matters related to classification and certification of the Units, unless the Rules provide otherwise.

3.4. - **The operations of the Society in providing its Services are exclusively conducted by way of random inspections and do not in any circumstances involve monitoring or exhaustive verification.**

ARTICLE 4

4.1. - The Society, acting by reference to its Rules:

- "reviews the construction arrangements of the Units as shown on the documents presented by the Client;
- "conducts surveys at the place of their construction;
- "classes Units and enters their class in its Register;
- "surveys periodically the Units in service to note that the requirements for the maintenance of class are met.

The Client is to inform the Society without delay of circumstances which may cause the date or the extent of the surveys to be changed.

ARTICLE 5

5.1. - **The Society acts as a provider of services. This cannot be construed as an obligation bearing on the Society to obtain a result or as a warranty.**

5.2. - **The certificates issued by the Society pursuant to 5.1. here above are a statement on the level of compliance of the Unit to its Rules or to the documents of reference for the Services provided for.**

In particular, the Society does not engage in any work relating to the design, building, production or repair checks, neither in the operation of the Units or in their trade, neither in any advisory services, and cannot be held liable on those accounts. Its certificates cannot be construed as an implied or express warranty of safety, fitness for the purpose, seaworthiness of the Unit or of its value for sale, insurance or chartering.

5.3. - **The Society does not declare the acceptance or commissioning of a Unit, nor of its construction in conformity with its design, that being the exclusive responsibility of its owner or builder.**

5.4. - The Services of the Society cannot create any obligation bearing on the Society or constitute any warranty of proper operation, beyond any representation set forth in the Rules, of any Unit, equipment or machinery, computer software of any sort or other comparable concepts that has been subject to any survey by the Society.

ARTICLE 6

6.1. - The Society accepts no responsibility for the use of information related to its Services which was not provided for the purpose by the Society or with its assistance.

6.2. - **If the Services of the Society or their omission cause to the Client a damage which is proved to be the direct and reasonably foreseeable consequence of an error or omission of the Society, its liability towards the Client is limited to ten times the amount of fee paid for the Service having caused the damage, provided however that this limit shall be subject to a minimum of eight thousand (8,000) Euro, and to a maximum which is the greater of eight hundred thousand (800,000) Euro and one and a half times the above mentioned fee. These limits apply regardless of fault including breach of contract, breach of warranty, tort, strict liability, breach of statute, etc.**

The Society bears no liability for indirect or consequential loss whether arising naturally or not as a consequence of the Services or their omission such as loss of revenue, loss of profit, loss of production, loss relative to other contracts and indemnities for termination of other agreements.

6.3. - All claims are to be presented to the Society in writing within three months of the date when the Services were supplied or (if later) the date when the events which are relied on of were first known to the Client, and any claim which is not so presented shall be deemed waived and absolutely barred. Time is to be interrupted thereafter with the same periodicity.

ARTICLE 7

7.1. - Requests for Services are to be in writing.

7.2. - **Either the Client or the Society can terminate as of right the requested Services after giving the other party thirty days' written notice, for convenience, and without prejudice to the provisions in Article 8 hereunder.**

7.3. - The class granted to the concerned Units and the previously issued certificates remain valid until the date of effect of the notice issued according to 7.2. here above subject to compliance with 2.3. here above and Article 8 hereunder.

7.4. - The contract for classification and/or certification of a Unit cannot be transferred neither assigned.

ARTICLE 8

8.1. - The Services of the Society, whether completed or not, involve, for the part carried out, the payment of fee upon receipt of the invoice and the reimbursement of the expenses incurred.

8.2. - **Overdue amounts are increased as of right by interest in accordance with the applicable legislation.**

8.3. - **The class of a Unit may be suspended in the event of non-payment of fee after a first unfruitful notification to pay.**

ARTICLE 9

9.1. - The documents and data provided to or prepared by the Society for its Services, and the information available to the Society, are treated as confidential. However:

- "Clients have access to the data they have provided to the Society and, during the period of classification of the Unit for them, to the **classification file** consisting of survey reports and certificates which have been prepared at any time by the Society for the classification of the Unit ;
- "copy of the documents made available for the classification of the Unit and of available survey reports can be handed over to another Classification Society, where appropriate, in case of the Unit's transfer of class;
- "the data relative to the evolution of the Register, to the class suspension and to the survey status of the Units, as well as general technical information related to hull and equipment damages, may be passed on to IACS (International Association of Classification Societies) according to the association working rules;
- "the certificates, documents and information relative to the Units classed with the Society may be reviewed during certificating bodies audits and are disclosed upon order of the concerned governmental or inter-governmental authorities or of a Court having jurisdiction.

The documents and data are subject to a file management plan.

ARTICLE 10

10.1. - Any delay or shortcoming in the performance of its Services by the Society arising from an event not reasonably foreseeable by or beyond the control of the Society shall be deemed not to be a breach of contract.

ARTICLE 11

11.1. - In case of diverging opinions during surveys between the Client and the Society's surveyor, the Society may designate another of its surveyors at the request of the Client.

11.2. - Disagreements of a technical nature between the Client and the Society can be submitted by the Society to the advice of its Marine Advisory Committee.

ARTICLE 12

12.1. - Disputes over the Services carried out by delegation of Governments are assessed within the framework of the applicable agreements with the States, international Conventions and national rules.

12.2. - Disputes arising out of the payment of the Society's invoices by the Client are submitted to the Court of Nanterre, France, or to another Court as deemed fit by the Society.

12.3. - **Other disputes over the present General Conditions or over the Services of the Society are exclusively submitted to arbitration, by three arbitrators, in London according to the Arbitration Act 1996 or any statutory modification or re-enactment thereof. The contract between the Society and the Client shall be governed by English law.**

ARTICLE 13

13.1. - **These General Conditions constitute the sole contractual obligations binding together the Society and the Client, to the exclusion of all other representation, statements, terms, conditions whether express or implied. They may be varied in writing by mutual agreement. They are not varied by any purchase order or other document of the Client serving similar purpose.**

13.2. - The invalidity of one or more stipulations of the present General Conditions does not affect the validity of the remaining provisions.

13.3. - The definitions herein take precedence over any definitions serving the same purpose which may appear in other documents issued by the Society.

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		Ch 9	Sec 1, Sec 4
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Part C	*NR 467 C1 DT R07 E*	Ch 1	Sec 2, Sec 3, Sec 6, Sec 7, Sec 9, Sec 10, Sec 11, Sec 15, App 1, App 2
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		Ch 10	Sec 1, Sec 5, Sec 6, Sec 7, Sec 10, Sec 11, Sec 14, Sec 20, Sec 21

Amendments to PART A

Ch 1, Sec 1, [4.1] (Amendments January 2015)

Replace requirement [4.1.4] by:

4.1.4 In statutory matters, when authorized by the Administration concerned and acting on its behalf, the Society applies the available IACS Unified Interpretations (UIs), unless provided with written instruction to apply a different interpretation by the flag Administration.

Ch 1, Sec 2, [4.4]

Insert the following requirement [4.4.6]:

4.4.6 LNG bunkering ship, for ships carrying liquefied natural gas (LNG) and intended to ensure the transfer of LNG to ships using LNG as fuel.

The additional requirements of Rule Note NR620 LNG Bunkering Ship are applicable to these ships.

The service notation may be completed by the following additional service features, as applicable:

- **RE**, where the ship is designed to receive LNG from a gas fuelled ship for which the LNG fuel tanks have to be emptied
- **Initial-CD**, where the ship is designed for initial cooling down of the gas fuelled ship LNG fuel tank
- **IG-Supply**, where the ship is designed to supply inert gas and dry air, to ensure gas freeing and aeration, to a gas fuelled ship complying with IGF Code, paragraph 6.10.4
- **BOG**, where the ship is designed to recover and manage the boil-off gas generated during the bunkering operation.

Ch 1, Sec 2, [4.7.6] (Amendments July 2015)

Replace the last paragraph of requirement [4.7.6] by:

The additional requirements of Ch 4, Sec 8, [10] and Pt D, Ch 14, Sec 2, [5] are applicable to these ships.

Ch 1, Sec 2, [4.7] (Amendments January 2015)

Add the following requirement [4.7.9]:

4.7.9 The service notation **lifting** is assigned to ships intended to perform lifting operations at sea.

The requirements for the assignment and maintenance of this notation are given respectively in Rule Note NR608 Classification of Lifting Units and in Ch 4, Sec 8, [12].

Note 1: For being eligible, at least one of the following additional class notations is to be assigned:

ALM, **ALS**, **OHS**

Ch 1, Sec 2, [4.13] (Amendments January 2015)

Replace requirement [4.13.1] by:

4.13.1 Elastic Shaft Alignment (ESA)

The additional service feature **ESA** is to be assigned to new ships designed with propulsion shaft line(s) falling into the categories as defined in Rule Note NR592 Elastic Shaft Alignment (ESA).

The criteria and requirements for the assignment of this additional service feature are given in Rule Note NR592.

Ch 1, Sec 2, Table 1

*Add the following row "**lifting**" and replace row "**Wind farms service ship**" in Table 1 by:* (Amendments January 2015)

*Replace rows "**Bulk carrier**" and "**Oil tanker**" as follows and insert the following table footnote **(10)**:* (Amendments July 2015)

*Add the following row "**LNG bunkering ship**":*

Table 1 : List of service notations and additional service features

Service notation [ref. in Part A] / Additional service feature		Reference	Corresponding type of ship according to Conventions and/or Codes
lifting [4.7.9]		Rule Note NR 608	
Wind farms service ship - Xi [4.15.7]		Guidance Note NI 589	
X = S, M or L; i = 0, 1 or 2			
Bulk carrier [4.3]		Part D, Chapter 4	Cargo ship (SOLAS, Reg I/2(g)) Bulk carrier (SOLAS, Reg XII/1)
ESP		Part D, Chapter 4 SOLAS, Reg IX/1.6 SOLAS, Reg XI-1/2	
BC-A or **BC-B** or **BC-C**	**(2)**	Part D, Chapter 4	
heavycargo [AREA1, X1 kN/m² - …]		Pt B, Ch 5, Sec 6	
nonhomload	**(3)**	–	
CSR		Rule Note NR 606 **(10)** Rule Note NR 522	
GRAB [X]	**(4)**	Rule Note NR 606 **(10)** NR 522, Ch 12, Sec 1	
CPS(WBT)	**(5)**	Rule Note NR 530	
Oil tanker [4.4.2]		Part D, Chapter 7	Tanker (SOLAS, Reg I/2(h)) Oil tanker (MARPOL Annex I, Reg I/1.5)
ESP		Part D, Chapter 7 SOLAS, Reg II-1/2.22 SOLAS, Reg XI-1/2	
flash point > 60°C		Part D, Chapter 7	
asphalt carrier		Part D, Chapter 7	
CSR		Rule Note NR 606 **(10)** Rule Note NR 523	
CPS(WBT)	**(5)**	Rule Note NR 530	
LNG bunkering ship [4.4.6]		Rule Note NR 620	Tanker (SOLAS, Reg I/2(h)) Gas carrier (SOLAS, Reg II-1/3.20, Reg II-2/3.25, Reg VII /11.2)
RE		Rule Note NR 620	
Initial-CD		Rule Note NR 620	
IG-Supply		Rule Note NR 620	
BOG		Rule Note NR 620	

(10) : Bulk carriers and oil tankers assigned with the additional service feature **CSR** contracted for new construction on or after 1 July 2015 are to comply with the requirements of NR 606 Common Structural Rules for Bulk Carriers and Oil Tankers.

Ch 1, Sec 2, [4.15] (Amendments January 2015)

Replace requirement [4.15.7] by:

4.15.7 The service notation **Wind farms service ship - Xi** is intended to cover ships specifically designed to operate in offshore wind farms for the typical following duties:

- transfer of personnel from shore to offshore wind farms or from mother ships or accommodation units at site to offshore wind farms
- lifting operations required for wind turbines assistance (transfer of materials on wind turbines platforms).

The service notation is to be completed by the additional service feature **Xi**, where:

X : Capacity parameter having one of the following values: **S**, **M**, or **L**

i : Type ship parameter having one of the following values: **0**, **1** or **2**.

Example: **Wind farms service ship - S0**

The requirements for the assignment of this service notation are given in the Guidance note NI 589 Wind Farms Service Ships.

Ch 1, Sec 2, [6.2] (Amendments July 2015)

Replace requirements [6.2.2] and [6.2.3] by:

6.2.2 VeriSTAR-HULL CM and VeriSTAR-HULL

The additional class notation **VeriSTAR-HULL CM** may be assigned to new ships, contracted for construction on or after the 1st July 2015, the structural condition of which is checked with 3D FEM calculation program at design stage, according to the requirements of the Society for which the hull surveys for new construction are carried out according to the requirements of Ch 3, Sec 7 and for which the requirements of Pt E, Ch 1, Sec 1 are fulfilled.

Existing ships contracted for construction before the 1st July 2015 and for which the structural condition is checked with 3D FEM calculation program at design stage according to the requirements of the Society may be assigned with the notation **VeriSTAR-HULL**.

VeriSTAR-HULL CM and **VeriSTAR-HULL** encompass the fatigue assessment carried out on selected structural details as per the requirements of Part B.

The requirements for the assignment of these notations are given in Pt E, Ch 1, Sec 1.

The additional class notations **VeriSTAR-HULL CM** and **VeriSTAR-HULL** may be completed by **DFL xx years**, with xx having values between 25 and 40, when a fatigue assessment has been carried out on selected structural details showing that their evaluated design fatigue life is not less than xx years.

The requirements for the assignment of **DFL xx years** are given in Pt B, Ch 7, Sec 4.

The additional class notations **VeriSTAR-HULL CM**, **VeriSTAR-HULL**, **VeriSTAR-HULL CM DFL xx years** and **VeriSTAR-HULL DFL xx years** may be assigned to ships of less than 170 m in length, subject to special consideration by the Society.

6.2.3 VeriSTAR-HULL SIS

The additional class notation **VeriSTAR-HULL SIS** may be assigned to ships in place of notations **VeriSTAR-HULL CM** and **VeriSTAR-HULL** when the structural condition is reassessed using survey data.

The requirements for the assignment and maintenance of this notation are given respectively in Pt E, Ch 1, Sec 1 and in Ch 5, Sec 2.

This notation is not applicable to ships assigned with the additional service feature **CSR**.

This notation may be completed by **DFL xx years** as detailed in [6.2.2].

Ch 1, Sec 2, [6.3] (Amendments July 2015)

Add the following requirement [6.3.5]:

6.3.5 Fire mitigation for main diesel-generator rooms (AVM-FIRE)

The additional class notation **AVM-FIRE** is assigned to ships which are fitted with an electrical production plant distributed over minimum two main diesel-generator rooms enabling to maintain sufficient operating functionality with respect to propulsion, safety, navigation and steering, and a minimum of 50% operability for defined habitability services in case of loss of one main diesel-generator room due to fire.

The additional class notation **AVM-FIRE** is assigned alone or in addition to the additional class notation **AVM-APS** or **AVM-DPS**.

Ch 1, Sec 2, Table 2

*Add the following rows “**MON-ICE**”, “**OHS**” and “**URN**” in Table 2:* (Amendments January 2015)

*Add the following rows “**AVM-FIRE**”, “**GAS-PREPARED**”, “**HEL**” and “**YOUNG ICE**”:* (Amendments July 2015)

*Insert the additional class notation “**VeriSTAR-HULL-CM**” in row “VeriSTAR” as follows:* (Amendments July 2015)

*Replace row “**GRAB [X]**” as follows and insert the following table footnote **(2)**:* (Amendments July 2015)

*Add the following rows “**BATTERY SYSTEM**” and “**SAFE-LASHING**”:*

Replace row “LI” by:

*Add the additional class notation “**SYS-NEQ-OSV**” in row “SYS” as follows:*

Table 2 : List of additional class notations

Additional class notation	Definition in	Reference in NR 467 or to other Rule Notes	Remarks
MON-ICE	[6.6.4]	Rule Note NR 616	**MON-ICE** is to be completed by criteria **L(i)**, where **i** is a (list of) Roman numeral(s) from **I** to **VII**, or/and **G**
OHS **(1)**	[6.14.34]	Rule Note NR 595	
URN	[6.14.35]	Rule Note NR 614	
AVM-FIRE **(1)**	[6.3.5]	Pt E, Ch 2, Sec 4	**AVM-FIRE** is assigned alone or in addition to **AVM-APS** or **AVM-DPS**
GAS-PREPARED **GAS-PREPARED ( )**	[6.14.36]	Rule Note NR 627	between brackets, the notation may be completed by one, more or all of the following notations: **S**, **P**, **ME-DF**, **AEB**
GRAB [X]	[6.14.2]	Rule Note NR 606 **(2)** Rule Note NR 522, Ch 12	on a voluntary basis for bulk carriers other than CSR BC-A or CSR BC-B
HEL **(1)**	[6.14.23]	Pt E, Ch 10, Sec 20	
VeriSTAR-HULL **(1)** **VeriSTAR-HULL CM**	[6.2.2]	Pt E, Ch 1, Sec 1	these notations may be completed by **DFL xx years**, with 25 ≤ xx ≤ 40
VeriSTAR-HULL SIS **(1)**	[6.2.3]		
YOUNG ICE 1 **YOUNG ICE 2**	[6.10.3]	Part E, Chapter 8	
BATTERY SYSTEM	[6.14.37]	Pt E, Ch 10, Sec 21	
LI-HG **LI-S1** **LI-S2** **LI-S3** **LI-HG-S1** **LI-HG-S2** **LI-HG-S3**	[6.14.28]	Pt B, Ch 10, Sec 2	
SAFE-LASHING	[6.14.38]	–	
SYS-COM **(1)**	[6.5.4]	Pt E, Ch 4, Sec 3	**SYS-COM** can only be assigned to ships which are also assigned the notation **AUT-IMS** **SYS-IBS** can only be assigned to ships which are also assigned the notation **SYS-NEQ** **SYS-IBS-1** can only be assigned to ships which are also assigned the notations **SYS-NEQ-1** and **AUT-UMS**
SYS-IBS **(1)** **SYS-IBS-1**	[6.5.3]	Pt E, Ch 4, Sec 2	
SYS-NEQ **(1)** **SYS-NEQ-1**	[6.5.2]	Pt E, Ch 4, Sec 1	
SYS-NEQ-OSV **(1)**	[6.5.5]	Rule Note NR 633	

(2) : Bulk carriers and Oil Tankers assigned with the additional service feature **CSR** contracted for new construction on or after 1 July 2015 are to comply with the requirements of NR 606 Common Structural Rules for Bulk Carriers and Oil Tankers.

Ch 1, Sec 2, [6.4.1] (Amendments January 2015)

Replace the last paragraph of requirement [6.4.1] by:

The requirements for the assignment and maintenance of these notations are given respectively in Part E, Chapter 3 and in Ch 5, Sec 4.

Ch 1, Sec 2, [6.5.1]

Replace the last paragraph of requirement [6.5.1] by:

The requirements for the assignment and maintenance of these additional class notations are given, as applicable, in:

- NR633 for the notation **SYS-NEQ-OSV**
- Part E, Chapter 4 and Ch 5, Sec 5, respectively, for the other notations **SYS**.

Ch 1, Sec 2, [6.5]

Add the following requirement [6.5.5]:

6.5.5 Bridge design and instrumentation (SYS-NEQ-OSV)

The additional class notation **SYS-NEQ-OSV** may be assigned to ships fulfilling specific requirements for bridge design and instrumentation, and, in addition, provided with further means for safe operation in all the waters, including areas with harsh operational and environmental conditions such as the North Sea.

The aim of the additional class notation **SYS-NEQ-OSV** is to reduce the risk, in bridge operation, of failure causing collision, contact and grounding.

The requirements for the assignment of this notation are given in Rule Note NR633.

Ch 1, Sec 2, [6.6.1] (Amendments January 2015)

Delete the second paragraph in requirement [6.6.1].

Ch 1, Sec 2, [6.6.2] (Amendments January 2015)

Add the following paragraph at the end of requirement [6.6.2]

The requirements for the assignment and maintenance of this notation are given respectively in Pt E, Ch 5, Sec 1 and in Ch 5, Sec 6.

Ch 1, Sec 2, [6.6.3] (Amendments January 2015)

Replace the last paragraph of requirement [6.6.3] by:

The requirements for the assignment and maintenance of this notation are given respectively in Pt E, Ch 5, Sec 2 and in Ch 5, Sec 6.

Ch 1, Sec 2, [6.6] (Amendments January 2015)

Add the following requirement [6.6.4]:

6.6.4 Ice load monitoring system (MON-ICE)

The additional class notation **MON-ICE** is assigned to ships which are fitted with equipment to continuously monitor ice loads exerted on ship's hull by ice formations.

The notation **MON-ICE** is to be completed by one of the criteria **L(i)** and **G**, as follows:

- **MON-ICE L(i)** for ships equipped with a local ice load monitoring system, where **i** is a (list of) Roman numeral(s) from **I** to **VII**, depending on the design scenario
- **MON-ICE G** for ships intended to perform ramming and required to be equipped with a hull girder ice load monitoring system.

Note: The above letters and numerals denote the location (i.e. areas and regions) of the sensors and the interaction scenario, and the two notations are cumulative.

Examples: **MON-ICE L(I, III, VI), MON-ICE G**

MON-ICE L(II), MON-ICE G

The requirements for the assignment and maintenance of these notations are given respectively in NR616 Ice Load Monitoring System (MON-ICE) and in Ch 5, Sec 6.

Ch 1, Sec 2, [6.7.1] (Amendments January 2015)

Replace the last paragraph of requirement [6.7.1] by:

The requirements for the assignment and maintenance of these notations are given respectively in Part E, Chapter 6 and in Ch 5, Sec 10.

Ch 1, Sec 2, [6.8.1] (Amendments January 2015)

Replace the last paragraph of requirement [6.8.1] by:

The requirements for the assignment and maintenance of these notations are given respectively in Part E, Chapter 9 and in Ch 5, Sec 7.

Ch 1, Sec 2, [6.9.1] (Amendments January 2015)

Replace the last paragraph of requirement [6.9.1] by:

The requirements for the assignment and maintenance of these notations are given respectively in Part E, Chapter 7 and in Ch 5, Sec 8.

Ch 1, Sec 2, [6.10.1] (Amendments January 2015)

Replace the second paragraph of requirement [6.10.1] by:

The requirements for the assignment and maintenance of these notations are given respectively in Part E, Chapter 8 and in Ch 5, Sec 9.

Ch 1, Sec 2, [6.10] (Amendments July 2015)

Replace requirement [6.10.3] by:

6.10.3 The additional class notations **ICE CLASS ID**, **YOUNG ICE 1** and **YOUNG ICE 2** are assigned to ships whose reinforcements for navigation in ice are different from those required for the assignment of the notations defined in [6.10.2] but who comply with the specific requirements detailed in Part E, Chapter 8.

Note 1: No minimum engine output is required for these notations.

Ch 1, Sec 2, [6.14]

Replace requirement [6.14.5] by: (Amendments July 2015)

6.14.5 Container lashing equipment

The additional class notation **LASHING** may be assigned to ships initially fitted with mobile container lashing equipment which has been documented, tested and checked.

The additional class notation **LASHING-WW** may be assigned in lieu of the notation **LASHING** to any ship, except if the intended navigation zone is identified as the North-Atlantic or North-Pacific area.

The additional class notation **LASHING (restricted area)** may be assigned in lieu of the notation **LASHING** to ships navigating only in specific restricted areas such as Baltic Sea, Mediterranean Sea or South China Sea.

These notations are assigned only to ships having the service notation **container ship** or the additional service feature **equipped for carriage of containers**.

This equipment, however, will not be verified any longer at the periodical class surveys to which the ship is submitted.

The requirements for the assignment of these notations are given in Pt E, Ch 10, Sec 5.

Replace requirement [6.14.17] by:

6.14.17 Sealed liquefied natural gas carriers

The additional class notation **IATP** (increased admissible cargo tank pressure) may be assigned to ships intended to carry methane (LNG) whose maximum cargo tank design pressure does not exceed 70 kPa and that are designed and built so as to allow the pressure in the tanks to increase above 25 kPa.

This notation may only be assigned to ships having the service notation **liquefied gas carrier** or **LNG bunkering ship**.

The requirements for the assignment of this notation are given in Pt E, Ch 10, Sec 14.

Insert the following requirement [6.14.23]: (Amendments July 2015)

6.14.23 Helideck (HEL)

The additional class notation **HEL** may be assigned to ships complying with chapter II-2 of SOLAS and Civil Aviation Publication (CAP) 437 when they are fitted with helicopter facilities subject to design review and construction and installation survey by the Society.

The requirements for the assignment and maintenance of this notation are given respectively in Pt E, Ch 10, Sec 20 and in Ch 5, Sec 10.

Add the following requirements [6.14.34] and [6.14.35]: (Amendments January 2015)

Add the following requirement [6.14.36]: (Amendments July 2015)

Add the following requirements [6.14.37] and [6.14.38]:

6.14.34 Offshore Handling Systems (OHS)

The additional class notation **OHS** may be assigned to ships having offshore handling systems such as winches, strand jacks, chain jacks, sheaves and their foundations used for lifting/pulling of a load.

The requirements for the assignment and maintenance of this notation are given respectively in NR595 Classification of Offshore Handling Systems and in Ch 5, Sec 10.

Note 1: Specific procedures for non-permanent equipment are not applicable for ships.

6.14.35 Underwater Radiated Noise (URN)

The additional class notation **URN** may be assigned to self-propelled ships meeting the underwater radiated noise level limits complying with the requirements of NR614 Underwater Radiated Noise (URN).

According to the limits given in Rule Note NR614, the notation **URN** is to be completed as follows:

URN - controlled vessel

URN - advanced vessel

URN - specified vessel

The requirements for the assignment and maintenance of this notation are given in Rule Note NR614.

6.14.36 GAS-PREPARED

The additional class notation **GAS-PREPARED** applies to new ships that are designed with specific arrangements to accommodate future installation of an LNG fuel gas system.

The requirements for the assignment of this notation are given in NR 627 Gas Prepared Ships;

The additional class notation **GAS-PREPARED** may be completed by the following additional notations:

- **S**, when specific arrangements are implemented for the ship structure
- **P**, when specific arrangements are implemented for piping
- **ME-DF**, when the main engine(s) is (are) of the dual fuel type
- **AEB**, when the auxiliary engines and oil-fired boilers are either of the dual fuel type, or designed for future conversion to dual-fuel operation.

Examples:

- **GAS-PREPARED**
- **GAS-PREPARED (P)**
- **GAS-PREPARED (P, ME-DF)**
- **GAS-PREPARED (S, P, ME-DF)**

Note 1: When the ship is effectively converted to dual-fuel operation, the additional class notation **GAS-PREPARED** will be replaced by the additional service feature **dualfuel**, provided that all the applicable requirements given in Ch 1, Sec 2, [4.11.1] are complied with.

6.14.37 BATTERY SYSTEM

The additional class notation **BATTERY SYSTEM** may be assigned to ships when batteries are used for propulsion and/or electric power supply purpose during operation of the ship. This notation is mandatory when the ship is only relying on batteries for propulsion and/or electrical power supply for main sources.

The requirements for the assignment of this notation are given in Pt E, Ch 10, Sec 21.

6.14.38 SAFE-LASHING

The additional class notation **SAFE-LASHING** may be assigned to ships having the service notation **container ship** or the additional service feature **equipped for carriage of containers** and the keel of which was laid, or which are at a similar stage of construction, on or after 1 January 2015.

The requirements for the assignment of this notation are given in IMO MSC.1/Circ.1352/Rev.1 "Amendments to the Code of Safe Practice for Cargo Stowage and Securing (CSS Code)", Annex 14 "Guidance on Providing Safe Working Conditions for Securing of Containers on Deck", paragraphs 4.3 "Cargo Safe Access Plan (CSAP)" and 6 "Design".

Ch 1, Sec 2, [6.15]

Replace requirement [6.15.2] by:

6.15.2 Inert gas

The additional class notation **IG** may be assigned to ships fitted with an inert gas system, as follows:

- Ships contracted for construction before 1 January 2016:

  This notation is assigned only to ships having the service notation:

  - **oil tanker** or **FLS tanker**, and of less than 20000 tonnes deadweight, or
  - **chemical tanker** for which an inert gas system is not required in pursuance of July 2014 edition of the Rules, Pt D, Ch 8, Sec 9, [1.3.1].

  The requirements for the assignment of the notation **IG** are given in July 2014 edition of the Rules:

  - Pt D, Ch 7, Sec 6, [5.1.2], for oil tankers or FLS tankers, and
  - Pt D, Ch 8, Sec 9, [2.5.3], for chemical tankers.

- Ships contracted for construction on or after 1 January 2016:

  This notation is assigned only to ships having the service notation **oil tanker**, **FLS tanker** or **chemical tanker**, and of less than 8000 tonnes deadweight.

  The requirements for the assignment of the notation **IG** are given in:

  - *(new)* Pt D, Ch 7, Sec 6, [5.1.3], for oil tankers or FLS tankers, and
  - *(new)* Pt D, Ch 8, Sec 9, [2.3], for chemical tankers.

Ch 1, Sec 2, [6.15.3]

Replace the second paragraph of requirement [6.15.3] by:

In principle, this notation is assigned only to ships of less than 20000 tonnes deadweight having one of the service notations **oil tanker**, **combination carrier/OBO**, **combination carrier/OOC**, **liquefied gas carrier**, **LNG bunkering ship**, **chemical tanker** and **FLS tanker**.

Ch 2, Sec 1, [3.2.3] (Amendments January 2015)

Replace items a) and b) of the alphanumeric list by:

a) Main plans:
- General arrangement
- Capacity plan
- Hydrostatic curves
- Loading manual, where required
- Damage Stability calculation, where required.

b) Hull structure plans:
- Midship section
- Scantling plan
- Decks
- Shell expansion
- Transverse bulkheads
- Rudder and rudder stock
- Hatch covers
- For ship assigned with the additional service feature **CSR**, plans showing, for each structural element, both as-built and renewal thicknesses and any thickness for "voluntary addition".

Ch 2, Sec 2, [2.1.5]

Replace the last paragraph of requirement [2.1.5] by:

Recommendations may be imposed in other cases, which, in the Society's opinion, require specific consideration.

Ch 2, Sec 2, [3.1.2] (Amendments July 2015)

Add the following paragraph at the end of requirement [3.1.2]:

The period of validity for the Provisional Certificate of Classification is not to exceed 6 months from the date of issuance.

Ch 2, Sec 2, [4.1.2] (Amendments January 2015)

Add the following paragraph at the end of requirement [4.1.2]:

In cases where the vessel has been laid up or has been out of service for a considerable period because of a major repair or modification and the Owner elects to carry out only the overdue surveys, the next period of class will start from the expiry date of the renewal survey. If the Owner elects to carry out the next due renewal survey, the period of class will start from the survey completion date.

Ch 2, Sec 2, [5.5]

Insert the following requirement [5.5.4]:

5.5.4 Survey of propeller shafts and tube shafts - Applicable requirements from 1 January 2016

Reference is to be made to Ch 3, Sec 5, [3] for revised requirements applicable to all ships with conventional shafting fitted with a propeller, unless alternative means are provided to assure the condition of the propeller shaft assembly.

Such requirements are applicable:
- from 1 January 2016, for ships delivered on or after 1 January 2016
- after the first shaft survey scheduled on or after 1 January 2016, for ships delivered before 1 January 2016.

On a case-by-case basis, these requirements may be applied before the above schedule.

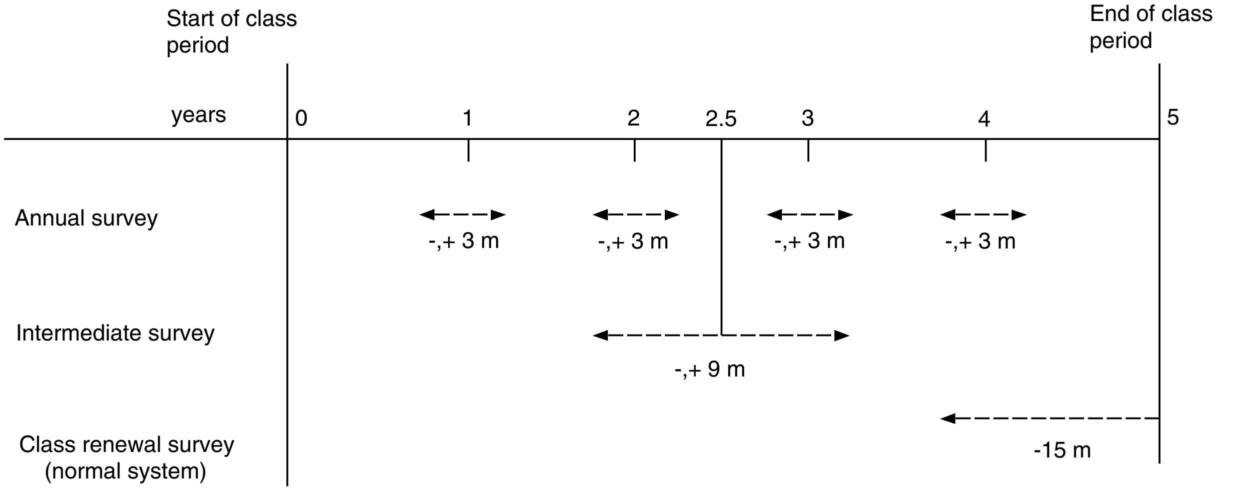
Ch 2, Sec 2, [5.7.1] (Amendments January 2015)

Reference to "Fig 3" is to be understood as reference to new Figure 3.

Ch 2, Sec 2 (Amendments January 2015)

Insert the following Figure 3:

Figure 3: Links between anniversary dates and annual, intermediate and class renewal surveys



Ch 2, App 2, [6.1] (Amendments July 2015)

Delete requirement [6.1.2] and replace requirement [6.1.1] by:

6.1.1 Where the condition of the items surveyed by the Chief Engineer as specified in his or her reports does not correspond to the findings of the attending Surveyor, or in case of doubt on the general maintenance of the machinery installation, the Society may request the Owner to withdraw the Chief Engineer qualification attestation until further training and re-assessment of his/her qualification.

Ch 3, Sec 1, [3.2] (Amendments July 2015)

Replace requirement [3.2.4] (from Amendments January 2015) by:

3.2.4 For electrical steam generators, a functional test while in operation is to be carried out, during which the following items are checked:

- the heater system for detection of leakages
- the operation of indication, control, alarm and safety devices.

Ch 3, Sec 4, [2.1] (Amendments July 2015)

Replace requirement [2.1.3] by:

2.1.3 Sea chests and their gratings, sea connections and overboard discharge valves and cocks and their fastenings to the hull or sea chests are to be examined. Sea valves and cocks need not be opened up more than once in a period of class unless considered necessary by the Surveyor.

Ch 3, Sec 5

Add the following Article [3], Figure 1, Table 1, Table 2 and Table 3:

3 Survey of propeller shafts and tube shafts

3.1 General

3.1.1 Application

Unless alternative means are provided to assure the condition of the propeller shaft assembly, these requirements apply to all ships with conventional shafting fitted with a propeller, as follows:

- from 1 January 2016, for ships delivered on or after 1 January 2016
- after the first shaft survey scheduled on or after 1 January 2016, for ships delivered before 1 January 2016.

  Note 1: Upon the completion of the first shaft survey scheduled on or after 1 January 2016, the designation of dates for the next shaft survey is to be made based upon the requirements of this Article.

3.1.2 Definitions

See also Fig 1.

a) Shaft

For the purpose of this Article, shaft is a general definition that includes:

- propeller shaft
- tube shaft.

The definition does not include the intermediate shafts which are considered as part of the propulsion shafting inside the ship.

b) Propeller shaft

Propeller shaft is the part of the propulsion shaft to which the propeller is fitted. It may also be called screwshaft or tailshaft.

c) Tube shaft

Tube shaft is a shaft placed between the intermediate shaft and the propeller shaft, normally arranged within a stern tube or running in open water. It may also be called sterntube shaft.

d) Sterntube

Tube or pipe fitted in the shell of a ship at the stern (or rear part of the ship), below the waterline, through which passes the tube shaft or the aftermost section of the propeller shaft.

Sterntube is the housing of the shaft bearings, generally two (one aft and one fore), that sustain the shaft and allow its rotation with less frictional resistance. The sterntube also accommodates the shaft sealing arrangement.

e) Closed loop (system) oil lubricated bearing

Closed loop oil lubricating systems use oil to lubricate the bearings and are sealed against the environment (seawater) by adequate sealing/gland devices.

f) Water lubricated bearing

Water lubricated bearings are bearings cooled/lubricated by water (fresh or salt).

g) Closed loop (system) fresh water lubricated bearing

Closed loop water lubricating systems use fresh water to lubricate the bearings and are sealed against the environment (such as seawater) by adequate sealing/gland devices.

h) Open systems (water)

Open water lubricating systems use water to lubricate the bearings and are exposed to the environment.

i) Adequate means for protection against corrosion

An adequate means for protection against corrosion is an approved means for full protection of the core shaft against sea water intrusion and subsequent corrosion attack. Such means are used for the protection of common steel material against corrosion, particularly in combination with water lubricated bearings.

Typical means are, for example:

- continuous metallic, corrosion resistant liners
- continuous cladding
- multiple layer synthetic coating
- multiple layer of fibreglass
- combinations of above mentioned
- rubber/elastomer covering coating.

The means for protection against corrosion are installed/applied according to class approved procedures.

j) Corrosion resistant shaft

Corrosion resistant shaft is made in approved corrosion resistant steel as core material for the shaft.

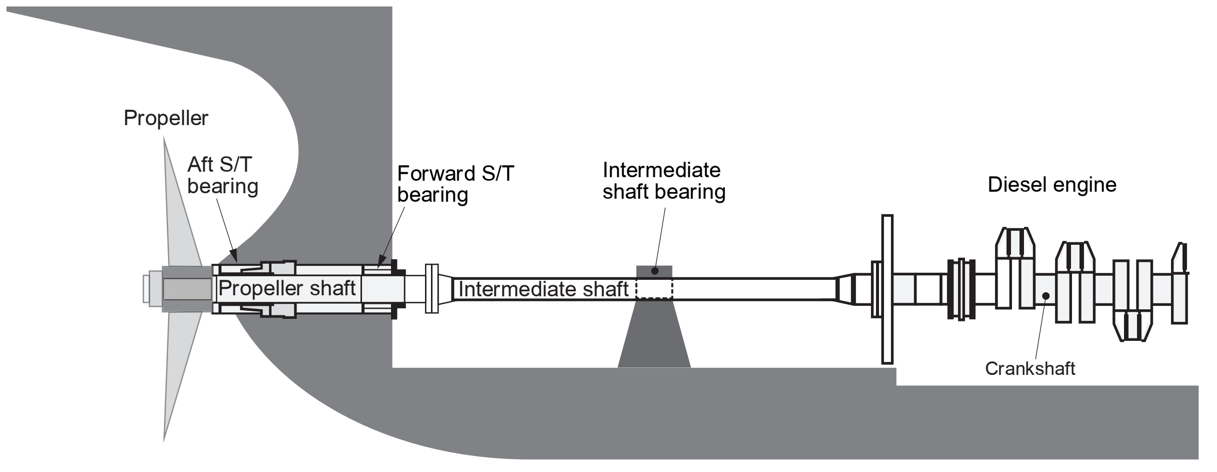
k) Sterntube sealing system

Sterntube sealing system is the equipment installed on the inboard extremity and, for closed systems, at outboard extremity of the sterntube.

Inboard seal is the device fitted on the fore part of the sterntube that achieves the sealing against the possible leakage of the lubricant media into the ship internal.

Outboard seal is the device fitted on the aft part of the sterntube that achieves the sealing against the possible sea water ingress and the leakage of the lubricant media.

Figure 1 : Typical shafting arrangement



l) Service records

Service records are regularly recorded data showing in-service conditions of the shaft(s) and may include, as applicable: lubricating oil temperature, bearing temperature and oil consumption records (for oil lubricated bearings) or water flow, water temperature, salinity, pH, make-up water and water pressure (for closed loop fresh water lubricated bearings, depending on the design).

m) Oil sample examination

Oil sample examination is a visual examination of the sterntube lubricating oil taken in the presence of the Surveyor, with a focus on water contamination.

n) Lubricating oil analysis

Lubricating oil analysis is to be carried out at regular intervals not exceeding 6 months.

The documentation on lubricating oil analysis is to be available on board.

Oil samples, to be submitted for the analysis, should be taken under service conditions.

o) Fresh water sample test

Fresh water sample test should be carried out at regular intervals not exceeding 6 months

Samples are to be taken under service conditions and are to be representative of the water circulating within the sterntube.

Analysis results are to be retained on board and made available to the Surveyor.

At time of survey, the sample for the test is to be taken in the presence of the Surveyor.

Fresh water sample test shall include the following parameters:

- chlorides content
- pH value
- presence of bearing particles or other particles (only for laboratory analysis, not required for tests carried out in the presence of the Surveyor).

p) Keyless connection

Keyless connection is the forced coupling methodology, between the shaft and the propeller without a key, achieved through the interference fit of the propeller boss on the shaft tapered end.

q) Keyed connection

Keyed connection is the forced coupling methodology, between the shaft and the propeller with a key and a keyway, achieved through the interference fit of the propeller boss on the shaft tapered end.

r) Flanged connection

Flanged connection is the coupling methodology, between the shaft and the propeller, achieved by a flange built-in at the shaft aft end and bolted to the propeller boss.

s) Alternative means

Shafting arrangements such as, but not limited to, an approved Condition Monitoring Scheme an/or other reliable approved means for assessing and monitoring the condition of the tail shaft, bearings, sealing devices and the sterntube lubricant system capable to assure the condition of the propeller shaft assembly with an equivalent level of safety as obtained by survey methods as applicable in [3.2] or [3.3].

3.2 Oil lubricated shafts or closed loop system fresh water lubricated shafts (closed system)

3.2.1 Shaft survey - Method 1

The survey is to consist in:

- Drawing the shaft and examining the entire shaft, seals system and bearings
- For keyed and keyless connections:
  - removing the propeller to expose the forward end of the taper
  - performing a non-destructive examination (NDE) by an approved surface crack detection method all around the shaft in way of the forward portion of the taper section, including the keyway (if fitted). For shaft provided with liners, the NDE shall be extended to the after edge of the liner

- For flanged connection:

  Whenever the coupling bolts of any type of flange-connected shaft are removed or the flange radius is made accessible in connection with overhaul, repairs, or when deemed necessary by the Surveyor, the coupling bolts and the flange radius are to be examined by means of an approved surface crack detection method
- Checking and recording the bearing clearances
- Verifying that the propeller is free of damages which may cause the propeller to be out of balance
- Verifying the satisfactory conditions of inboard and outboard seals during reinstallation of the shaft and the propeller
- Recording the bearing weardown measurements (after reinstallation).

3.2.2 Shaft survey - Method 2

The survey is to consist of:

- For keyed and keyless connections:
  - removing the propeller to expose the forward end of the taper
  - performing a non-destructive examination (NDE) by an approved surface crack detection method all around the shaft in way of the forward portion of the taper section, including the keyway (if fitted)
- For flanged connection:

  Whenever the coupling bolts of any type of flange-connected shaft are removed or the flange radius is made accessible in connection with overhaul, repairs, or when deemed necessary by the Surveyor, the coupling bolts and the flange radius are to be examined by means of an approved surface crack detection method
- Checking and recording of the bearing weardown measurements
- Visual inspection of all the accessible parts of the shafting system
- Verification that the propeller is free of damages which may cause the propeller to be out of balance
- Seal liner found to be or placed in a satisfactory condition
- Verification of the satisfactory reinstallation of the propeller, including verification of the satisfactory conditions of inboard and outboard seals.

Prerequisites, to satisfactorily verify in order to apply method 2, are the following ones:

- Review of service records
- Review of test records of:
  - lubricating oil analysis (for oil lubricated shafts), or
  - fresh water sample test (for closed system fresh water lubricated shafts)
- Oil sample examination (for oil lubricated shafts), or fresh water sample test (for closed system fresh water lubricated shafts)
- Verification of no reported repairs by grinding or welding of shaft and/or propeller.

3.2.3 Shaft survey - Method 3

The survey is to consist of:

- Checking and recording of the bearing weardown measurements
- Visual inspection of all the accessible parts of the shafting system
- Verification that the propeller is free of damages which may cause the propeller to be out of balance
- Seal liner found to be or placed in a satisfactory condition
- Verification of the satisfactory conditions of inboard and outboard seals.

Prerequisites, to satisfactorily verify in order to apply method 3, are the following ones:

- Review of service records
- Review of test records of:
  - lubricating oil analysis (for oil lubricated shafts), or
  - fresh water sample test (for closed system fresh water lubricated shafts)
- Oil sample examination (for oil lubricated shafts), or fresh water sample test (for closed system fresh water lubricated shafts)
- Verification of no reported repairs by grinding or welding of shaft and/or propeller.

3.2.4 Shaft extension surveys - Extension types

a) Extension up to 2,5 years

   The survey is to consist of:

   - Checking and recording of the bearing weardown measurements, as far as practicable
   - Visual inspection of all the accessible parts of the shafting system
   - Verification that the propeller is free of damages which may cause the propeller to be out of balance
   - Verification of the effectiveness of the inboard seal and outboard seals.

   Prerequisites, to satisfactorily verify in order to apply extension up to 2,5 years, are the following ones:

   - Review of service records
   - Review of test records of:
     - lubricating oil analysis (for oil lubricated shafts), or
     - fresh water sample test (for closed system fresh water lubricated shafts)
   - Oil sample examination (for oil lubricated shafts), or fresh water sample test (for closed system fresh water lubricated shafts)
   - Verification of no reported repairs by grinding or welding of shaft and/or propeller
   - Confirmation from the Chief Engineer that the shafting arrangement is in good working condition.

b) Extension up to 1 year

The survey is to consist of:

- Visual inspection of all the accessible parts of the shafting system
- Verification that the propeller is free of damages which may cause the propeller to be out of balance
- Verification of the effectiveness of the inboard seal and outboard seals.

Prerequisites, to satisfactorily verify in order to apply extension up to 1 year, are the following ones:

- Review of the previous weardown and/or clearance recordings
- Review of service records
- Review of test records of:
  - lubricating oil analysis (for oil lubricated shafts), or
  - fresh water sample test (for closed system fresh water lubricated shafts)
- Oil sample examination (for oil lubricated shafts), or fresh water sample test (for closed system fresh water lubricated shafts)
- Verification of no reported repairs by grinding or welding of shaft and/or propeller
- Confirmation from the Chief Engineer that the shafting arrangement is in good working condition.

c) Extension up to 3 months

The survey is to consist of:

- Visual inspection of all the accessible parts of the shafting system
- Verification of the effectiveness of the inboard seal.

Prerequisites, to satisfactorily verify in order to apply extension up to 3 month, are the following ones:

- Review of the previous weardown and/or clearance recordings
- Review of service records
- Review of test records of:
  - lubricating oil analysis (for oil lubricated shafts), or
  - fresh water sample test (for closed system fresh water lubricated shafts)
- Oil sample examination (for oil lubricated shafts), or fresh water sample test (for closed system fresh water lubricated shafts)
- Verification of no reported repairs by grinding or welding of shaft and/or propeller
- Confirmation from the Chief Engineer that the shafting arrangement is in good working condition.

3.2.5 Oil lubricated shafts

a) Survey intervals (see Tab 1)

For surveys completed within 3 months before the shaft survey due date, the next period will start from the shaft survey due date.

1) Flanged propeller connection

The following methods are applicable:

- method 1 every 5 years, or
- method 2 every 5 years (prerequisites have to be fulfilled), or
- method 3 every 5 years (prerequisites have to be fulfilled).

2) Keyless propeller connection

The following methods are applicable:

- method 1 every 5 years, or
- method 2 every 5 years (prerequisites have to be fulfilled), or
- method 3 every 5 years (prerequisites have to be fulfilled).

The maximum interval between two surveys carried out according to method 1 or method 2 shall not exceed 15 years, except in the case when one extension for no more than three months is granted.

3) Keyed propeller connection

The following methods are applicable:

- method 1 every 5 years, or
- method 2 every 5 years (prerequisites have to be fulfilled).

b) Survey extensions (see Tab 1)

For all types of propeller connections, the interval between two consecutive surveys may be extended after execution of the extension survey, as follows:

- Extension up to a maximum of 2,5 years

  No more than one “2,5 year extension” can be granted. No further extension, of other type, can be granted.
- Extension up to a maximum of 1 year

  No more than two consecutive “one year extension” can be granted. In the event an additional extension is requested, the requirements of the “2,5 year extension” are to be carried out and the shaft survey due date, prior to the previous extension(s), is extended for a maximum of 2,5 years.
- Extension up to a maximum of 3 months

  No more than one “three month extension” can be granted. In the event an additional extension is requested, the requirements of the “one year extension” or “2,5 year extension” are to be carried out and the shaft survey due date, prior to the previous extension, is extended for a maximum of one year or 2,5 years.

The extension survey should normally be carried out within 1 month of the shaft survey due date and the extension counts from the shaft survey due date.

If the extension survey is carried out more than 1 month prior to the shaft survey due date, then the period of extension counts from the date the extension survey was completed.

Table 1 : Survey intervals for oil lubricated shafts (closed systems)

	Flanged propeller coupling	Keyless propeller coupling	Keyed propeller coupling **(2)**
Every five years **(1)**	method 1 or method 2 or method 3	method 1 or method 2 or method 3 **(3)**	method 1 or method 2
Extension 2,5 Y	yes **(4)**	yes **(4)**	yes **(4)**
Extension 1 Y	yes **(5)**	yes **(5)**	yes **(5)**
Extension 3 M	yes **(6)**	yes **(6)**	yes **(6)**

Note 1: For surveys (method 1, or method 2, or method 3) completed within 3 months before the shaft survey due date, the next period will start from the shaft survey due date.
The extension survey should normally be carried out within 1 month of the shaft survey due date and the extension counts from the shaft survey due date. If the extension survey is carried out more than 1 month prior to the shaft survey due date, then the period of extension counts from the date the extension survey was completed.
(1) Unless an extension type (extension 2,5 Y, or extension 1 Y, or extension 3 M) is applied in between.
(2) Method 3 is not allowed.
(3) The maximum interval between two surveys carried out according to method 1 or method 2 shall not exceed 15 years, except in the case when one extension for no more than three months is granted.
(4) No more than one "2,5 year extension" can be granted. No further extension, of other type, can be granted.
(5) No more than two consecutive "one year extension" can be granted. In the event an additional extension is requested, the requirements of the "2,5 year extension" are to be carried out and the shaft survey due date, prior to the previous extension(s), is extended for a maximum of 2,5 years.
(6) No more than one "three month extension" can be granted. In the event an additional extension is requested, the requirements of the "one year extension" or "2,5 year extension" are to be carried out and the shaft survey due date, prior to the previous extension, is extended for a maximum of one year or 2,5 years.

Table 2 : Survey intervals for closed loop system fresh water lubricated shafts (closed systems)

	Flanged propeller coupling	Keyless propeller coupling	Keyed propeller coupling **(2)**
Every five years **(1)**	method 1 **(3)** or method 2 or method 3	method 1 **(3)** or method 2 or method 3	method 1 **(3)** or method 2
Extension 2,5 Y	yes **(4)**	yes **(4)**	yes **(4)**
Extension 1 Y	yes **(5)**	yes **(5)**	yes **(5)**
Extension 3 M	yes **(6)**	yes **(6)**	yes **(6)**

Note 1: For surveys (method 1, or method 2, or method 3) completed within 3 months before the shaft survey due date, the next period will start from the shaft survey due date.
The extension survey should normally be carried out within 1 month of the shaft survey due date and the extension counts from the shaft survey due date. If the extension survey is carried out more than 1 month prior to the shaft survey due date, then the period of extension counts from the date the extension survey was completed.
(1) Unless an extension type (extension 2,5 Y, or extension 1 Y, or extension 3 M) is applied in between.
(2) Method 3 is not allowed.
(3) The maximum interval between two surveys carried out according to method 1 shall not exceed 15 years.
(4) No more than one "2,5 year extension" can be granted. No further extension, of other type, can be granted.
(5) No more than two consecutive "one year extension" can be granted. In the event an additional extension is requested, the requirements of the "2,5 year extension" are to be carried out and the shaft survey due date, prior to the previous extension(s), is extended for a maximum of 2,5 years.
(6) No more than one "three month extension" can be granted. In the event an additional extension is requested, the requirements of the "one year extension" or "2,5 year extension" are to be carried out and the shaft survey due date, prior to the previous extension, is extended for a maximum of one year or 2,5 years.

3.2.6 Closed loop system fresh water lubricated shafts

The maximum interval between two surveys carried out according to method 1 shall not exceed 15 years. An extension for no more than three months can be granted.

a) Survey intervals (see Tab 2)

   For surveys completed within 3 months before the shaft survey due date, the next period will start from the shaft survey due date.

1) Flanged propeller connection

   The following methods are applicable:

   - method 1 every 5 years, or
   - method 2 every 5 years (prerequisites have to be fulfilled), or
   - method 3 every 5 years (prerequisites have to be fulfilled).

2) Keyless propeller connection

The following methods are applicable:

- method 1 every 5 years, or
- method 2 every 5 years (prerequisites have to be fulfilled), or
- method 3 every 5 years (prerequisites have to be fulfilled).

3) Keyed propeller connection

The following methods are applicable:

- method 1 every 5 years, or
- method 2 every 5 years (prerequisites have to be fulfilled).

b) Survey extensions (see Tab 2)

For all types of propeller connections, the interval between two consecutive surveys may be extended after execution of the extension survey, as follows:

- Extension up to a maximum of 2,5 years

  No more than one “2,5 year extension” can be granted. No further extension, of other type, can be granted.

- Extension up to a maximum of 1 year

  No more than two consecutive “one year extension” can be granted. In the event an additional extension is requested, the requirements of the “2,5 year extension” are to be carried out and the shaft survey due date, prior to the previous extension(s), is extended for a maximum of 2,5 years.

- Extension up to a maximum of 3 months

  No more than one “three month extension” can be granted. In the event an additional extension is requested, the requirements of the “one year extension” or “2,5 year extension” are to be carried out and the shaft survey due date, prior to the previous extension, is extended for a maximum of one year or 2,5 years.

The extension survey should normally be carried out within 1 month of the shaft survey due date and the extension counts from the shaft survey due date.

If the extension survey is carried out more than 1 month prior to the shaft survey due date, then the period of extension counts from the date the extension survey was completed.

The maximum interval between two surveys carried out according to method 1 shall not exceed 15 years, except in the case when one extension for no more than three months is granted.

3.3 Water lubricated shafts (open systems)

3.3.1 Shaft survey - Method 4

The survey is to consist in:

- Drawing the shaft and examining the entire shaft (including liners, corrosion protection system and stress reducing features, where provided), inboard seal system and bearings
- For keyed and keyless connections:
  - removing the propeller to expose the forward end of the taper
  - performing a non-destructive examination (NDE) by an approved surface crack detection method all around the shaft in way of the forward portion of the taper section, including the keyway (if fitted). For shaft provided with liners, the NDE shall be extended to the after edge of the liner
- For flanged connection:

  Whenever the coupling bolts of any type of flange-connected shaft are removed or the flange radius is made accessible in connection with overhaul, repairs, or when deemed necessary by the Surveyor, the coupling bolts and the flange radius are to be examined by means of an approved surface crack detection method
- Checking and recording the bearing clearances
- Verifying that the propeller is free of damages which may cause the propeller to be out of balance
- Verifying the satisfactory conditions of inboard seal during reinstallation of the shaft and the propeller.

3.3.2 Shaft extension surveys - Extension types

a) Extension up to 1 year

The survey is to consist of:

- Visual inspection of all the accessible parts of the shafting system
- Verification that the propeller is free of damages which may cause the propeller to be out of balance
- Checking and recording of the clearances of bearing
- Verification of the effectiveness of the inboard seal.

Prerequisites, to satisfactorily verify in order to apply extension up to 1 year, are the following ones:

- Review of the previous clearance recordings
- Service records
- Verification of no reported repairs by grinding or welding of shaft and/or propeller
- Confirmation from the Chief Engineer that the shafting arrangement is in good working condition.

b) Extension up to 3 months

The survey is to consist of:

- Visual inspection of all the accessible parts of the shafting system
- Verification that the propeller is free of damages which may cause the propeller to be out of balance
- Verification of the effectiveness of the inboard seal.

Prerequisites, to satisfactorily verify in order to apply extension up to 3 months, are the following ones:

- Review of the previous clearance recordings
- Service records
- Verification of no reported repairs by grinding or welding of shaft and/or propeller
- Confirmation from the Chief Engineer that the shafting arrangement is in good working condition.

3.3.3 Shaft survey intervals

a) Survey intervals (see Tab 3)

The following survey intervals according to method 4 are applicable to all types of propeller connections:

- for keyless propeller connections, the maximum interval between two consecutive dismantling and verifications of the shaft cone by means of non-destructive examination (NDE) shall not exceed 15 years
- for surveys completed within 3 months before the shaft survey due date, the next period will start from the shaft survey due date.

1) Configurations allowing 5 year intervals
   - single shaft operating exclusively in fresh water
   - single shaft provided with adequate means of corrosion protection, single corrosion resistant shaft
   - all kinds of multiple shafts arrangements.

2) Other systems

   Shaft not belonging to one of the configurations listed in item 1) has to be surveyed according to method 4 every 3 years.

b) Survey extensions (see Tab 3)

For all types of propeller connections, the interval between two consecutive surveys may be extended after execution of the extension survey, as follows:

- Extension up to a maximum of 1 year

  No more than one "one year extension" can be granted. No further extension, of other type, can be granted.

- Extension up to a maximum of 3 months

  No more than one "three month extension" can be granted. In the event an additional extension is requested, the requirements of the "one year extension" are to be carried out and the shaft survey due date, prior to the previous extension, is extended for a maximum of one year.

The extension survey should normally be carried out within 1 month of the shaft survey due date and the extension counts from the shaft survey due date.

If the extension survey is carried out more than 1 month prior to the shaft survey due date, then the period of extension counts from the date the extension survey was completed.

Table 3 : Survey intervals for water lubricated shafts (open systems)

	All kinds of propeller coupling **(4)**	
• Single shaft operating exclusively in fresh water • Single shaft provided with adequate means of corrosion protection, single corrosion resistant shaft • All kinds of multiple shaft arrangements	Every five years **(1)**	Method 4
	Extension 1 Y	yes **(2)**
	Extension 3 M	yes **(3)**

	All kinds of propeller coupling **(4)**	
Other shaft configuration	Every three years **(1)**	Method 4
	Extension 1 Y	yes **(2)**
	Extension 3 M	yes **(3)**

Note 1: For surveys (method 4) completed within 3 months before the shaft survey due date, the next period will start from the shaft survey due date.

The extension survey should normally be carried out within 1 month of the shaft survey due date and the extension counts from the shaft survey due date. If the extension survey is carried out more than 1 month prior to the shaft survey due date, then the period of extension counts from the date the extension survey was completed.

(1) Unless an extension type (extension 1 Y, or extension 3 M) is applied in between.

(2) No more than one "one year extension" can be granted. No further extension, of other type, can be granted.

(3) No more than one "three month extension" can be granted. In the event an additional extension is requested, the requirements of the "one year extension" are to be carried out and the shaft survey due date, prior to the previous extension, is extended for a maximum of one year.

(4) For keyless propeller connections, the maximum interval between two consecutive dismantling and verifications of the shaft cone by means of non-destructive examination (NDE) shall not exceed 15 years.

Ch 3, Sec 6, [1.1] (Amendments January 2015)

Add the following requirement [1.1.8]:

1.1.8 For electrical steam generators, in addition to the above requirements on the water-steam side, the following items are to be verified:

- condition of the electrical insulation resistance of the heating elements
- verification of proper operation and functioning of indication, remote control, automatic alarm and safety devices
- verification of absence of signs of corrosion and leakage of water
- opening-up of forced circulation pumps, wherever possible.

Ch 3, Sec 7, [2.1.2] (Amendments July 2015)

Add the following item i) in the alphanumeric list at the end of requirement [2.1.2]:

i) hot spot map of the structure, when additional class notation **VeriSTAR-HULL CM** is assigned.

Ch 3, App 1, [3.3.3]

Replace the last paragraph of requirement [3.3.3] by:

Fresh water or distilled water tanks are to be kept full or empty. Empty tanks are to be cleaned and kept dry. Where cement wash is used as a protective sheathing, this is to be examined and repaired prior to filling.

Ch 3, App 1, [5.1]

Replace requirement [5.1.2] by:

5.1.2 Upon satisfactory completion of this survey, a memoranda is issued to confirm that the ship has been placed in lay-up, which is subsequently to be kept on board.

Ch 3, App 1, [5.3]

Replace requirement [5.3.13] by:

5.3.13 Upon satisfactory completion of the surveys, a memoranda is issued to confirm the carrying out of all relevant surveys and the recommissioning of the ship.

Ch 4, Sec 1, Table 1 (Amendments January 2015)

*Add the following rows "**lifting**", "**diving support-**", "**yacht**" and "**charter yacht**" in Table 1:*

*Replace row "**anchor handling vessel**" in Table 1 by:*

Table 1 : Service notations for which specific requirements are applicable

Service notation assigned	Section or Article applicable in this Chapter	Type of surveys affected by these specific requirements	Remarks
anchor handling vessel	Ch 4, Sec 8, [10]	annual survey class renewal survey	
lifting	*(new)* Ch 4, Sec 8, [12]	annual survey class renewal survey	
diving support-integrated **diving support-portable**	Ch 4, Sec 8, [12]	annual survey class renewal survey	
yacht **charter-yacht**	Ch 4, Sec 8, [15]	intermediate survey	

Ch 4, Sec 2, [1.4] (Amendments January 2015)

Delete requirement [1.4.2].

Ch 4, Sec 3, [1.4] (Amendments January 2015)

Delete requirement [1.4.2].

Ch 4, Sec 4, [1.4] (Amendments January 2015)

Delete requirement [1.4.2].

Ch 4, Sec 8, [1.1.1] (Amendments January 2015)

Insert the following eleventh item in the bullet list of requirement [1.1.1]:

- **lifting**, in *(new)* Article [12]

Ch 4, Sec 8 (Amendments January 2015)

Insert the following Article [12]:

12 Lifting

12.1 General

12.1.1 The requirements of this Article are additional to those laid down in NR526 Rules for the Certification of Lifting Appliances onboard Ships and Offshore Units or NR595 Classification of Offshore Handling Systems, whichever is applicable.

12.2 Annual survey

12.2.1 The survey is to include verification and testing of the lifting equipment, as follows:

- verification of the presence onboard of the following documents:
  - technical manual
  - planned maintenance system
- general examination of the electrical cabling
- functional testing of the main and alternative two-way communication system at the lifting operating position
- verification of the structural arrangement and foundations of the lifting equipment
- testing of hydraulic installations
- load tests in accordance with the rules or requirements referred to in the lifting equipment certificate.

12.3 Class renewal survey

12.3.1 The requirements given in Rule Notes NR526 and NR595 are applicable for renewal survey.

In addition, load tests in accordance with the rules or requirements referred to in the lifting equipment certificate are to be carried out.

Ch 5, Sec 1, Table 1

Add, in the first column of Table 1, the additional class notations: (Amendments January 2015)

- *"**MON-ICE L(i)**" and "**MON-ICE G**" in the row "Monitoring equipment", and*
- *"**OHS**" in the row "Other notations".*

Add, in the first column of Table 1, the additional class notations: (Amendments July 2015)

- *"**AVM-FIRE**" in the row "Availability of machinery"*
- *"**YOUNG ICE 1**" and "**YOUNG ICE 2**" in the row "Navigation in ice environment", and*
- *"**HEL**" in the row "Other notations".*

Ch 5,Sec 3, [1.1.1] (Amendments July 2015)

*Add the additional class notations "**AVM-FIRE**" at the end of the list in requirement [1.1.1].*

Ch 5,Sec 6, [1.1.1] (Amendments January 2015)

*Add the additional class notations "**MON-ICE L(i)**" and "**MON-ICE G**" at the end of the list in requirement [1.1.1].*

Ch 5, Sec 6 (Amendments January 2015)

Add the following Article [4]:

4 MON-ICE L(i) and MON-ICE G

4.1 Annual survey

4.1.1 The Owner or his representative is to declare to the attending Surveyor that:

- all the components of the ice load monitoring system are able to ensure the main functions
- the ice load monitoring equipment has been calibrated complying with the declaration of the Manufacturer for the period and procedure of calibration.

Ch 5, Sec 9, [1.1.1] (Amendments July 2015)

*Add the additional class notations "**YOUNG ICE 1**" and "**YOUNG ICE 2**" between "**ICE CLASS ID**" and "**ICE**" in the list of requirement [1.1.1].*

Ch 5, Sec 10, [1.1.1]

*Add the additional class notation "**OHS**" at the end of the list in requirement [1.1.1].* (Amendments January 2015).

*Add the additional class notation "**HEL**" at the end of the list in requirement [1.1.1].* (Amendments July 2015)

Ch 5, Sec 10

Add the following Article [13]: (Amendments January 2015)

13 Offshore handling systems (OHS)

13.1 Application

13.1.1 The requirements of this Article apply to ships which have been assigned the additional class notation **OHS**, as defined in Ch 1, Sec 2, [6.14.33].

13.2 Periodical surveys

13.2.1 For survey requirements and for periodical surveys, refer to Section 4 of NR595 Classification of Offshore Handling Systems.

Add the following Article [14]: (Amendments July 2015)

14 Helideck (HEL)

14.1 Application

14.1.1 The requirements of this Article apply to ships which have been assigned the additional class notation **HEL**, as defined in Ch 1, Sec 2, [6.14.23].

14.2 Annual surveys

14.2.1 The Society considers that as a minimum these following issues are to be examined during the periodic surveys to confirm that there has been no alteration or deterioration in the condition of the helicopter landing area:

a) The general examination of the physical characteristics of the helideck is to include:
   - the dimensions as measured
   - the declared D-value
   - the deck shape, and
   - the scale drawings of deck arrangement.

b) The general examination of the preservation of obstacle-protected surfaces is to include:
   - the minimum 210° Obstacle Free Sector (OFS) surface
   - the 150° Limited Obstacle Sector (LOS) surface, and
   - the minimum 180° falling 5:1 gradient surface with respect to significant obstacles.

Note 1: If one or more of these surfaces is/are infringed due, for example, to the proximity of an adjacent installation or vessel, an assessment is to be made to determine any possible negative effect which may lead to operating restrictions.

c) The general examination of the marking and lighting is to include:
   - the adequate helideck perimeter lighting
   - the adequate helideck touchdown marking lighting ("H" and TD/PM Circle lighting) and/or floodlighting
   - the status lights (for day and night operations)
   - the helideck markings
   - the dominant obstacle paint schemes and lighting, and
   - the general installation lighting levels including floodlighting.

Note: Where inadequate helideck lighting exists, the Helideck Limitation List (HLL) is to be annotated "daylight only operations".

d) The general examination of the deck surface is to include:
   - the surface friction
   - the helideck net (as applicable)
   - the drainage system
   - the deck edge perimeter safety netting
   - the tie-down points, and
   - the cleaning of all contaminants (to maintain satisfactory recognition of helideck markings and preservation of the helideck friction surface).

e) The verification of the environment effects is to include:
   - foreign object damage
   - air quality degradation due to exhaust emissions, hot and cold vented gas emissions and physical turbulence generators
   - bird control
   - any adjacent helideck/installation having significant environmental effects in any air quality assessment, and
   - flares.

f) The general examination of the rescue and fire fighting facilities is to include:
   - the primary and complementary media types, quantities, capacity and systems
   - the Personal Protective Equipment (PPE), and
   - the crash box.

g) The general examination of the communications and navigation system arrangements is to include:
   - the aeronautical radio(s)
   - the radio/telephone (R/T) call sign to match helideck name and side identification which should be simple and unique
   - the Non-Directional Beacon (NDB) or equivalent (as appropriate), and
   - the radio log.

h) The general examination of the fuelling facilities is to include:

- the fuel system, ventilation, fire protection and detection
- the pump and aircraft bonding safety systems.

i) The general examination of the additional operational and handling equipment is to include:

- the windsock
- the meteorological information (recorded by an automated means)
- the Helideck Motion System recording and reporting (where applicable)
- the passenger briefing system
- the chocks
- the tie-downs, and
- the weighing scales for passengers, baggage and freight.

Amendments to PART B

Ch 1, Sec 1, [1.2] (Amendments January 2015)

Add the following requirement [1.2.3]:

1.2.3 The foundations of lifting appliances intended to be used at sea are to comply with the requirements of NR608 Classification of Lifting Units, Section 4.

Ch 1, Sec 2, [3]

Add the following sub-article [3.23]:

3.23 Sister ship

3.23.1 A sister ship is a ship built by the same yard from the same plans.

Ch 2, Sec 1, Table 2 (Amendments July 2015)

Replace the head of Table 2 as follows and add the following table footnote (6):

Table 2 : Doors

			Sliding type			Hinged type **(6)**			Rolling type (cargo between deck spaces)
			Remote operation indication on the bridge	Indicator on the bridge and locally	Local operation only	Remote operation indication on the bridge	Indicator on the bridge and locally	Local operation only	

(6) Hinged doors shall be of quick acting or single action type.

Ch 2, Sec 2, [2.1]

Delete requirement [2.1.3]

Ch 3, Sec 1, [1] (Amendments January 2015)

Add the following sub-article [1.3]:

1.3 Application to ships performing lifting operations at sea

1.3.1 In addition to the requirements of the present Chapter, ships performing lifting operations at sea are to comply with the stability requirements of NR608 Classification of Lifting Units, Section 3, as appropriate.

Ch 3, Sec 1, [2.2.2]

Add the following paragraph at the end of requirement [2.2.2]:

The inclining test or lightweight test report is to be signed by the Surveyor to confirm the information witnessed during the test. In addition, for ships performing regular adjustments of equipment such as for example supply vessels, the report is to include the detailed list of the major equipment on the decks, if they are included in the lightship particulars.

Ch 3, App 1, [1.1.1]

Replace the eighth item of the bulleted list by:

- the weights necessary for the inclination are to be already on board, located in the correct place. Their certificates are to be presented to the Surveyor witnessing the inclining test and are also to be included into the inclining test report.

Ch 3, App 2, [1.2.1]

Add the following paragraph at the end of requirement [1.2.1]:

The heel at the equilibrium of any sailing condition is not to be greater than 1°.

Ch 4, Sec 1, Table 1

Replace the last row of Table 1 as follow:

Table 1 : Mechanical properties of hull steels

Steel grades $t \leq 100$ mm	Minimum yield stress R_{eH} , in N/mm²	Ultimate minimum tensile strength R_m , in N/mm²
EH47 EH47CAS	460	570 - 720

Ch 4, Sec 1, Table 2

*Replace the last row as follows and add the following footnote **(1)** in Table 2:*

Table 2 : Material factor k

R_{eH} , in N/mm²	k
390	0,68 **(1)**

(1) The material factor k may be taken equal to 0,66 for steels with yield stress equal to 390 N/mm², provided that the hull structure is additionally verified for compliance with finite element analysis and spectral fatigue assessment according to NI539, Spectral Fatigue Analysis Methodology for Ships and Offshore Units.

Ch 4, Sec 3, [3.1.2] (Amendments July 2015)

Replace "α" by "φ" in the formula of "b_f" and in the corresponding definition, as follows:

$$b_f = \varphi\left[t'_w + \frac{h'_w}{6{,}7} - 2\right]$$

φ : Coefficient taken equal to:

$$1{,}1 + \frac{(120 - h'_w)^2}{3000} \quad \text{for } h'_w \le 120$$

$$1{,}0 \quad \text{for } h'_w > 120$$

Ch 4, Sec 3, [3.4] (Amendments July 2015)

Replace requirement [3.4.3] by:

Add the following Table 1 and Table 2:

Insert the following Figure B:

3.4.3 Plastic section modulus

The net plastic section modulus Z_{pl}, in cm^3, of stiffeners with attached plating is to be obtained from the following formulae:

- for $75° \le \alpha \le 90°$:

$$Z_{pl} = \frac{f_w h_w^2 t_w}{2000} + (2\gamma - 1)\frac{A_f h_{f-ctr}}{1000}$$

- for $\alpha < 75°$:

$$Z_{pl} = \frac{f_w h_w^2 t_w}{2000}\sin\alpha + (2\gamma - 1)\frac{A_f(h_{f-ctr}\sin\alpha - b_{f-ctr}\cos\alpha)}{1000}$$

where:

α : Angle as defined in [3.1.1]

f_w : Web shear stress factor, taken equal to:

- f_w = 0,75 for flanged profile cross-sections with at least one supported end
- f_w = 1,0 for flanged profile cross-sections with no support at ends
- f_w = 1,0 for flat bar stiffeners

h_w : Web height, in mm.

For bulb profiles, h_w is to be taken equal to d_w as given in Tab 1 and Tab 2

$$\gamma = 0{,}25(1 + \sqrt{3 + 12\beta})$$

β : Coefficient equal to:

- β = 0,5 in general
- for L profiles without mid-span tripping bracket:

$$\beta = \frac{t_w^2 f_b \ell^2}{80 b_f^2 t_f h_w} 10^6 + \frac{t_w}{2 b_f}$$

without being taken greater than 0,5

f_b : Coefficient equal to:

- f_b = 0,8 for flanges continuous through the primary structure, with end bracket(s)
- f_b = 0,7 for flanges sniped at the primary structure or terminated at the support without aligned structure on the other side of the support, and with end brackets
- f_b = 1,0 for other stiffeners

A_f : Net cross-sectional area of flange, in mm^2, taken equal to:

- A_f = 0 for flat bar stiffeners
- $A_f = b_f t_f$ for other stiffeners (for bulb profiles, values of b_f and t_f are given in Tab 1 and Tab 2)

$b_{f\text{-}ctr}$: Distance, in mm, from mid-thickness of the stiffener web to the centre of the flange area, taken equal to:

- $b_{f\text{-}ctr} = 0{,}5\,(b_f - t_w)$ for rolled angle profiles
- $b_{f\text{-}ctr} = 0$ for T-profiles
- as given in Tab 1 and Tab 2 for bulb profiles (see Fig B)

$h_{f\text{-}ctr}$: Height of the stiffener, in mm, measured to the mid-thickness of the flange, taken equal to:

- $h_{f\text{-}ctr} = h_w - 0{,}5\, t_f$ in general
- as given in Tab 1 and Tab 2 for bulb profiles (see Fig B).

Table 1 : Characteristic data for HP bulb profiles

h'_w (mm)	d_w (mm)	$b_{f\text{-}gr}$ (mm)	$t_{f\text{-}gr}$ (mm)	$b_{f\text{-}ctr}$ (mm)	$h_{f\text{-}ctr}$ (mm)
200	171	40	14,4	10,9	188
220	188	44	16,2	12,1	206
240	205	49	17,7	13,3	225
260	221	53	19,5	14,5	244
280	238	57	21,3	15,8	263
300	255	62	22,8	16,9	281
320	271	65	25,0	18,1	300
340	288	70	26,4	19,3	318
370	313	77	28,8	21,1	346
400	338	83	31,5	22,9	374
430	363	90	33,9	24,7	402

Note 1: See Fig B.

Note 2: Characteristic data converted to net scantlings are given as:

b_f equivalent to $b_{f\text{-}gr} + 2\, t_w$

$t_f = t_{f\text{-}gr} - t_c$

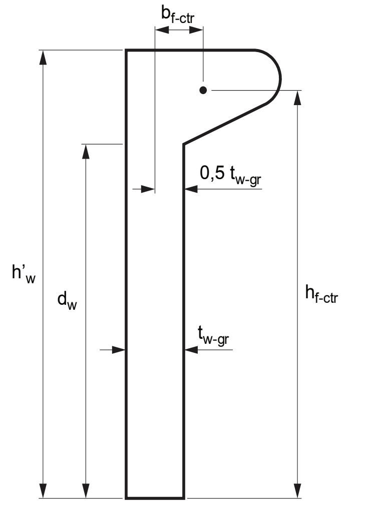
$t_w = t_{w\text{-}gr} - t_c$

t_c : As defined in Ch 4, Sec 2.

Table 2 : Characteristic data for JIS bulb profiles

h'_w (mm)	d_w (mm)	b_{f-gr} (mm)	t_{f-gr} (mm)	b_{f-ctr} (mm)	h_{f-ctr} (mm)
180	156	34	11,9	9,0	170
200	172	39	13,7	10,4	188
230	198	45	15,2	11,7	217
250	215	49	17,1	12,9	235
Note 1 and Note 2 of Tab 1 are applicable.					

Figure B : Characteristic data for bulb profiles



Ch 4, Sec 3, [4]

Replace sub-article [4.4] by:

4.4 Bracketed end connections

4.4.1 General

Brackets or equivalent structure are to be provided at ends of primary supporting members.

End brackets are generally to be soft-toed.

Bracketless connections may be applied according to [4.5] provided that there is adequate support of adjoining face plates.

4.4.2 Scantling of end brackets

In general, with the exception of primary supporting members of transversely framed single sides (see Ch 4, Sec 5, [3.2]), the arm length of brackets connecting PSMs, as shown in Fig C, is not to be less than the web depth of the member, and need not be taken greater than 1,5 times the web depth.

In general, the bracket thickness is not to be less than the thickness of the adjoining primary supporting member web plate.

The scantling of the end brackets is to be such that the section modulus of the primary supporting member with end bracket, excluding face plate where it is sniped, is not less than the section modulus of the primary supporting member at mid-span.

The net cross-sectional area A_f , in cm², of bracket face plates is to be such that:

$A_f \geq \ell_b \, t_b$

where:

ℓ_b : Length of the bracket edge, in m (see Fig C). For curved brackets, the length of the bracket edge may be taken as the length of the tangent at the midpoint of the edge

t_b : Minimum net bracket web thickness, in mm:

$$t_b \geq (2 + 0,2\sqrt{w})\sqrt{\frac{R_{eH,S}}{R_{eH,B}}}$$

with:

w : Net required section modulus of the primary supporting member, in cm³.

$R_{eH,S}$: Minimum yield stress, in N/mm², of the stiffener material.

$R_{eH,B}$: Minimum yield stress, in N/mm², of the bracket material.

Moreover, the net thickness of the bracket face plate is not to be less than the net thickness of the bracket web.

4.4.3 Arrangement of end brackets

Where length ℓ_b of the bracket free edge is greater than 1,5 m, the web of the bracket is to be stiffened as follows:

- the net sectional area, in cm², of stiffener webs is not to be less than 16,5 ℓ, where ℓ is the span, in m, of the stiffener
- tripping flat bars are to be fitted. Where the width of the symmetrical face plate is greater than 400 mm, additional backing brackets are to be provided.

For a ring system, where the end bracket is integral with the web of the members and the face plate is welded continuously onto the edge of the members and the bracket, the full area of the larger face plate is to be maintained close to the mid-point of the bracket and gradually tapered to the smaller face plate. Butts in face plates are to be kept well clear of the bracket toes.

Where a wide face plate abuts a narrower one, the taper is not to be greater than 1 to 4.

The bracket toes are not to land on unstiffened plating. The toe height is not to be greater than the thickness of the bracket toe, but need not be less than 15 mm. In general, the end brackets of primary supporting members are to be soft-toed. Where primary supporting members are constructed of steel having a strength higher than the strength of the bracket steel, particular attention is to be paid to the design of the end bracket toes in order to minimise stress concentrations.

Where a face plate is welded onto, or adjacent to, the edge of the end bracket (see Fig D), the face plate is to be sniped and tapered at an angle not greater than 30°.

4.4.4 Requirements for symmetrical face plates

Where face plates of end connecting brackets are symmetrical, the following requirements are in general to be complied with:

- face plates are to be tapered at ends with a total angle not greater than 30°
- the breath of face plates at ends is not to be greater than 25 mm
- face plates of 20 mm thick and above are to be tapered in thickness at their ends down to their mid-thickness
- bracket toes are to be of increased thickness
- an additional tripping bracket is to be fitted
- the radius R of the face plate is to be as large as possible
- collar plates welded to the plating are to be fitted in way of the bracket toes
- throat thickness of fillet welds is not to be less than t/2, with t being the thickness of the bracket toe.

An example of bracket with symmetrical face plate is indicated in *(existing)* Fig 14.

4.4.5 In addition, the net scantling of end brackets is to comply with the applicable requirements given from Ch 4, Sec 4 to Ch 4, Sec 7.

Ch 4, Sec 3

Insert the following Figure C and Figure D:

Figure C : Bracket dimensions

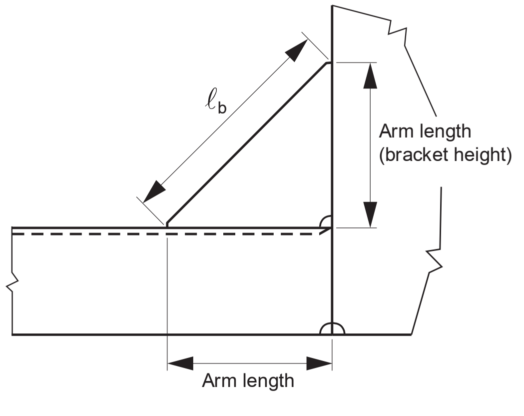
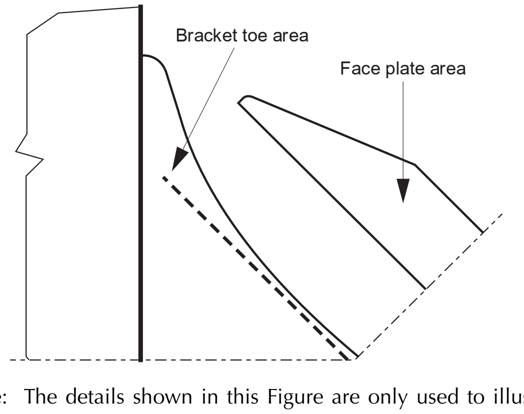


Figure D : Bracket face plate adjacent to the edge



Note: The details shown in this Figure are only used to illustrate items described in the text and are not intended to represent a design guidance or recommendations.

Ch 4, Sec 5, [1]

Replace sub-article [1.3] by:

1.3 Sheerstrake

1.3.1 The width of the sheerstrake, in m, is to be not less than 0,8 + L/200, measured vertically, but need not be greater than 1,8 m.

1.3.2 The sheerstrake may be either welded to the stringer plate or rounded. If the sheerstrake is rounded, its radius, in mm, is to be not less than 17 t_s , where t_s is its net thickness, in mm.

1.3.3 The upper edge of the welded sheerstrake is to be rounded, smooth, and free of notches. Fixtures, such as bulwarks and eye plates, are not to be directly welded on the upper edge of the sheerstrake, except in fore and aft parts. Drainage openings with a smooth transition in the longitudinal direction may be permitted.

1.3.4 The transition from a rounded sheerstrake to an angled sheerstrake associated with the arrangement of the superstructures is to be designed to avoid any discontinuities.

Drawings showing the details of this transition are to be submitted for approval to the Society.

1.3.5 The longitudinal seam welds of a rounded sheerstrake are to be located outside the bent area, at a distance not less than 5 times the maximum net thickness of the sheerstrake.

1.3.6 The welding of deck fittings onto rounded sheerstrakes is to be avoided within 0,6 L amidships.

Ch 4, Sec 6, [1.4]

Replace requirement [1.4.1] by:

1.4.1 The width of the stringer plate, in m, is to be not less than 0,8 + L/200, measured parallel to the deck, but need not be greater than 1,8 m.

However, the stringer plate is also to comply with the requirements of Ch 4, Sec 1, [2.4.5] and Ch 4, Sec 1, [2.5.5].

Rounded stringer plates, where adopted, are to comply with the requirements of Ch 4, Sec 5, [1.3] for rounded sheerstrakes.

Ch 4, Sec 7, [1.5] (Amendments July 2015)

Replace requirement [1.5.1] by:

1.5.1 The net scantlings of watertight doors is to be not less than that required in Ch 8, Sec 12.

Ch 5, Sec 5, Table 2 (Amendments July 2015)

Replace "Freeboard deck" by "Freeboard deck and below" in the first row of Table 2.

Ch 5, Sec 5, Table 3 (Amendments July 2015)

Replace the row "Sides above the waterline" in Table 3 by:

Table 3 : Wave pressure on sides and bottom in upright ship conditions (load cases "a" and "b")

Location	Wave pressure p_W, in kN/m²	
	Crest	Trough
Sides above the waterline ($z > T_1$)	$\rho\, g\, (T_1 + h - z)$ without being taken, for case "a" only, less than 0,15 $\varphi_1\, \varphi_2$ L	0,0

Ch 5, Sec 5, Table 5 (Amendments July 2015)

Replace the row “Sides above the waterline” in Table 5 by:

Table 5 : Wave pressure on sides, bottom and exposed decks in inclined ship conditions (load cases “c” and “d”)

Location	Wave pressure p_W, in kN/m² (negative roll angle) **(1)**	
	$y \geq 0$	$y < 0$
Sides above the waterline ($z > T_1$)	$\rho g \left[T_1 + C_{F2}\left(\frac{y}{B_W} h_1 + A_R y\right) - z\right]$ without being taken, for case “c” only, less than $0{,}15\ \varphi_1\ \varphi_2\ L$	0

Ch 5, Sec 6, [2.5]

Replace requirements [2.5.1] and [2.5.2] by:

2.5.1 Upright ship condition

Where there is a risk of resonance in upright ship condition, for tanks having arrangements such that ℓ_S is greater than 0,13 L at any filling level d_F from 0,05 H to 0,95 H, the dynamic impact pressure due to liquid motions is to be considered as acting on:

- transverse bulkheads which form tank boundaries, in the area extended vertically 0,15 H from the tank top
- the tank top in the area extended longitudinally 0,3 ℓ_C from the above transverse bulkheads.

However, the dynamic impact pressure may not be considered for filling levels d_F lower than 0,5 H.

Where the upper part of a transverse bulkhead is sloped, the impact pressure is to be considered as acting on the sloped part of the transverse bulkhead and the tank top (as the case may be) in the area extended longitudinally 0,3 ℓ_C from the transverse bulkhead.

The impact pressure is obtained, in kN/m², from the following formula:

$$p_{I,U} = \varphi_U \rho_L g \ell_C A_P \left(0{,}9 + \frac{\ell_C}{L}\right)(5 + 0{,}015L)$$

where:

φ_U : Coefficient defined in Tab 5

A_P : Pitch amplitude, in rad, defined in Ch 5, Sec 3, [2].

Where the upper part of a transverse bulkhead is sloped, the pressure $p_{I,U}$ may be multiplied by the coefficient ϕ obtained from the following formula:

$$\phi = 1 - \frac{h_T}{0{,}3H}$$

to be taken not less than zero,

where:

h_T : Height, in m, of the sloped part of the transverse bulkhead.

2.5.2 Inclined ship condition

Where there is a risk of resonance in inclined ship condition, for tanks having arrangements such that b_S is greater than 0,56 B at any filling level d_F from 0,05 H to 0,95 H, the dynamic impact pressure due to liquid motions is to be considered as acting on:

- longitudinal bulkheads, inner sides or sides which, as the case may be, form tank boundaries, in the area extended vertically 0,15 H from the tank top
- the tank top in the area extended transversely 0,3b_C from the above longitudinal bulkheads, inner sides or sides.

However, the dynamic impact pressure may not be considered for filling levels d_F lower than 0,5H.

Where the upper part of a longitudinal bulkhead, inner side or side is sloped, the impact pressure is to be considered as acting on this sloped part and the tank top (as the case may be) in the area extended transversely 0,3 b_C from the longitudinal bulkhead, inner side or side.

The impact pressure is obtained, in kN/m², from the following formula:

$$p_{I,I} = 0{,}61\varphi_I \rho_L g(0{,}75B - 8) b_C A_R$$

where:

φ_I : Coefficient defined in Tab 5.

Where the upper part of a longitudinal bulkhead, inner side or side is sloped, the pressure $p_{I,I}$ may be multiplied by the coefficient ϕ obtained from the following formula:

$$\phi = 1 - \frac{h_T}{0{,}3H}$$

to be taken not less than zero,

where:

h_T : Height, in m, of the sloped part of the longitudinal bulkhead, inner side or side.

Ch 5, Sec 6, Table 14

Delete row "Independant tanks" and insert the following row "Fuel oil tanks":

Table 14 : Testing - Still water pressures

Compartment or structure to be tested	Still water pressure p_{ST}, in kN/m^2
Fuel oil tanks	The greater of the following: $p_{ST} = 10\ [(z_{TOP} - z) + d_{AP}]$ $p_{ST} = 10\ [(z_{TOP} - z) + 2{,}4]$ $p_{ST} = 10\ [(z_{TOP} - z) + 10\ p_{PV}]$ $p_{ST} = 10\ (z_{BD} - z)$
Note 1: z_{BD} : Z co-ordinate, in m, of the bulkhead deck z_{TOP} : Z co-ordinate, in m, of the deck forming the top of the tank excluding any hatchways.	

Ch 6, Sec 1, [2.1]

Add the following requirement [2.1.10]:

2.1.10 Bilge keels

Bilge keels may not be included in the hull girder transverse sections, as they are considered not contributing to the hull girder sectional area.

Ch 6, Sec 2, [4.4.1] (Amendments January 2015)

Replace the formula of I_{YR} by:

$$I_{YR} = 3\frac{n}{n_1}Z'_{R,\,MIN}L \cdot 10^{-2}$$

Ch 7, Sec 1, Table 1 (Amendments January 2015)

Delete column "Impact pressure" (fifth column).

Ch 7, Sec 1, [1.4.1] (Amendments July 2015)

Replace the last item of the bullet list by:

- for transverse framing, at the lower edge of elementary plate panel or at the lower strake welding joint, if any.

Ch 7, Sec 1, [2.2] (Amendments July 2015)

Replace requirement [2.2.1] by:

2.2.1 The net thickness of plating is to be not less than the values given in Tab 2, where L need not be taken greater than 300 m.

Ch 7, Sec 1, [3] (Amendments January 2015)

Add the following sub-article [3.6]:

3.6 Plating subject to impact loads

3.6.1 General

Unless otherwise specified, the net thickness of plate panels subject to impact generated by fluids is to be not less than the value obtained, in mm, from the following formula:

$$t = \frac{15,8\alpha s}{C_d}\sqrt{\frac{P_I}{R_{eH}}}$$

where:

α : Coefficient defined as follows:

$$\alpha = 1,2 - \frac{s}{2,1\ell}$$

without being taken greater than 1,0.

C_d : Plate capacity correction coefficient:

- $C_d = 1,0$ for sloshing and flat bottom forward impact
- $C_d = 1,2$ for bow flare impact
- $C_d = 1,3$ for flat area of the bottom aft

P_I : Any impact pressure defined in the Rules, including:

- bottom impact pressure, as defined in Pt B, Ch 8, Sec 1, [3.2]
- bow impact pressure, as defined in Pt B, Ch 8, Sec 1, [4.2]
- dynamic impact pressure, as defined in Pt B, Ch 5, Sec 6, [2.5]
- stern impact pressure, as defined in Pt B, Ch 8, Sec 2, [4.2].

If deemed necessary by the Society and depending on specific natures of loadings, different calculation methods may be applied, on a case-by-case basis.

Ch 7, Sec 2, [4.4.1] (Amendments July 2015)

Replace the first paragraph of requirement [4.4.1] by:

The critical buckling stress of the ordinary stiffener parallel to the direction of compression, as shown in Fig 5, is to comply with the following formula:

Ch 7, Sec 2, [4.4.2] (Amendments July 2015)

Replace the first paragraph of requirement [4.4.2] by:

The net moment of inertia I, in cm^4, of stiffeners perpendicular to the direction of compression, as shown in Fig 6, is to be not less than the greatest value obtained from the following formulae:

Replace the first item of the bullet list by:

- $I = 11,4\, s t_w (2,5\,\ell^2 - 2s^2)\dfrac{R_{eH}}{235}$

Ch 7, Sec 2, Table 1 (Amendments January 2015)

Delete column “Impact pressure” (fifth column).

Ch 7, Sec 2, [3] (Amendments January 2015)

Add the following sub-article [3.10]:

3.10 Net section modulus and net shear sectional area of ordinary stiffeners subject to impact loads

3.10.1 Single span longitudinal, transverse and vertical ordinary stiffeners

Unless otherwise specified, the net plastic section modulus Z_{pl}, in cm^3, as defined in Ch 4, Sec 3, [3.4.3] and the net web thickness t_w, in mm, of stiffeners subject to impact generated by fluids are to be not less than the values obtained from the following formulae:

$$Z_{pl} = \frac{P_I}{0,9 \times 4(n+2)R_{eH}} s\ell^2 10^3$$

$$t_w = \frac{\sqrt{3}}{2} \frac{P_I}{(h_w + t_p) R_{eH}} s \ell 10^3$$

where:

P_I : Any impact pressure defined in the Rules, including:

- bottom impact pressure, as defined in Pt B, Ch 8, Sec 1, [3.2]
- bow impact pressure, as defined in Pt B, Ch 8, Sec 1, [4.2]
- dynamic impact pressure, as defined in Pt B, Ch 5, Sec 6, [2.5]
- stern impact pressure, as defined in Pt B, Ch 8, Sec 2, [4.2]

n : Number of fixed ends of stiffener:

- n = 2 for continuous members or members with brackets fitted at both ends
- n = 1 for one end equivalent to built-in and the other end simply supported
- n = 0 for both ends with low end fixity

t_p : Attached plating net thickness, in mm.

If deemed necessary by the Society and depending on specific natures of loadings, different calculation methods may be applied, on a case-by-case basis.

Ch 7, Sec 3 (Amendments July 2015)

Replace Table 2, Table 3 and Table 5 by:

Table 2 : Primary supporting members analysed through isolated beam models - Partial safety factors

Partial safety factors covering uncertainties regarding:	Symbol	Yielding check			Buckling check	
		General (see [3.4] to [3.7])	Flooding pressure **(1)** (see [3.8])	Testing check (see [3.9])	Plate panels (see [6.1])	Pillars (see [6.2] and [6.3])
Still water hull girder loads	γ_{S1}	1,00	1,00	NA	1,00	1,00
Wave hull girder loads	γ_{W1}	1,15	1,15	NA	1,15	1,15
Still water pressure	γ_{S2}	1,00	1,00	1,00	1,00	1,00
Wave pressure	γ_{W2}	1,20	1,05	NA	1,20	1,20
Material	γ_m	1,02	1,02	1,02	1,02	1,02
Resistance	γ_R	1,02 in general 1,15 for bottom and side girders	1,02 **(2)**	1,20	1,10	for [6.2]: see Tab 13 for [6.3]: 1,15

(1) Applies only to primary supporting members to be checked in flooding conditions
(2) For primary supporting members of the collision bulkhead, γ_R = 1,25

Table 3 : Primary supporting members analysed through three dimensional models - Partial safety factors

Partial safety factors covering uncertainties regarding:	Symbol	Yielding check (see [4])			Buckling check	
		General	Flooding pressure **(1)**	Testing check	Plate panels (see [6.1])	Pillars (see [6.2] and [6.3])
Still water hull girder loads	γ_{S1}	1,00	1,00	NA	1,00	1,00
Wave hull girder loads	γ_{W1}	1,05	1,05	NA	1,05	1,05
Still water pressure	γ_{S2}	1,00	1,00	1,00	1,00	1,00
Wave pressure	γ_{W2}	1,10	1,10	NA	1,10	1,10
Material	γ_m	1,02	1,02	1,02	1,02	1,02
Resistance	γ_R	defined in Tab 5	defined in Tab 5	defined in Tab 5	1,02 **(2)**	for [6.2]: see Tab 13 for [6.3]: 1,15

(1) Applies only to primary supporting members to be checked in flooding conditions
(2) For corrugated bulkhead platings, γ_R = 1,10
Note 1: For primary supporting members of the collision bulkhead, γ_R = 1,25

Table 5 : Primary supporting members analysed through three dimensional or complete ship models Resistance partial safety factor

Type of three dimensional model (see Ch 7, App 1)	Resistance partial safety factor γ_R (see [4.4] and [5.3])		
	General	Flooding pressure	Testing check
Beam model	1,20	1,02	1,20
Coarse mesh finite element model	1,20	1,02	1,20
Standard mesh finite element model	1,05	1,02	1,05
Fine mesh finite element model	1,05	1,02	1,05

Ch 7, Sec 3, [3] (Amendments July 2015)

Add the following sub-article [3.9]:

3.9 Net section modulus and net shear sectional area of primary supporting members subjected to lateral pressure in testing conditions

3.9.1 General

The requirements in [3.9.2] and [3.9.3] provide the minimum net section modulus and net shear sectional area of primary supporting members of compartments subject to testing conditions.

3.9.2 Longitudinal and transverse primary supporting members

The net section modulus w, in cm^3, and the net shear sectional area A_{Sh} , in cm^2, of longitudinal or transverse primary supporting members are to be not less than the values obtained from the following formulae:

$$w = \gamma_R \gamma_m \beta_b \frac{\gamma_{S2} p_T}{m R_y} s \ell^2 10^3$$

$$A_{Sh} = 10 \gamma_R \gamma_m \beta_s \frac{\gamma_{S2} p_T}{R_y} s \ell$$

where:

β_b, β_s : Coefficients defined in [3.5.2].

3.9.3 Vertical primary supporting members

The net section modulus w, in cm^3, and the net shear sectional area A_{Sh} , in cm^2, of vertical primary supporting members are to be not less than the values obtained from the following formulae:

$$w = \gamma_R \gamma_m \lambda_b \beta_b \frac{\gamma_{S2} p_T}{m R_y} s \ell^2 10^3$$

$$A_{Sh} = 10 \gamma_R \gamma_m \lambda_s \beta_s \frac{\gamma_{S2} p_T}{R_y} s \ell$$

where:

β_b, β_s : Coefficients defined in [3.5.2]

λ_b : Coefficient taken equal to the greater of the following values:

$$\lambda_b = 1 + 0,2 \frac{p_{Td} - p_{Tu}}{p_{Td} + p_{Tu}}$$

$$\lambda_b = 1 - 0,2 \frac{p_{Td} - p_{Tu}}{p_{Td} + p_{Tu}}$$

λ_s : Coefficient taken equal to the greater of the following values:

$$\lambda_s = 1 + 0,4 \frac{p_{Td} - p_{Tu}}{p_{Td} + p_{Tu}}$$

$$\lambda_s = 1 - 0,4 \frac{p_{Td} - p_{Tu}}{p_{Td} + p_{Tu}}$$

p_{Td} : Still water pressure, in kN/m^2, in testing conditions, at the lower end of the primary supporting member considered

p_{Tu} : Still water pressure, in kN/m^2, in testing conditions, at the upper end of the primary supporting member considered.

Ch 7, Sec 3, [4.4.3] (Amendments July 2015)

Replace the beginning of requirement [4.4.3] by:

4.4.3 Structural detail analysis based on fine mesh finite elements models

In a standard mesh model as defined in Ch 7, App 1, [3.4.3], high stress areas for which σ_{VM} exceeds 0,95 σ_{MASTER} are to be investigated through a fine mesh structural detail analysis according to Ch 7, App 1, [3.4.4], and both following criteria are to be checked:

Ch 7, Sec 3, [4.4.4] (Amendments July 2015)

Replace "very fine mesh" by "fine mesh" in the title of requirement [4.4.4] and in the second item of the bullet list.

Ch 7, Sec 3, [4.4.5] (Amendments July 2015)

Replace "very fine mesh" by "fine mesh" in the first paragraph of requirement [4.4.5].

Ch 7, Sec 3, [6.1.1] (Amendments July 2015)

Replace "fine mesh" by "standard mesh" in the first item of the bullet list of [6.1.1] (July 2014 issue).

Ch 7, Sec 3 (Amendments July 2015)

Replace (new) Article [6] (from amendments January 2015) by:

6 Primary members subject to impact loads

6.1 General

6.1.1 The net section modulus w, in cm^3, of primary supporting members and their net shear area A_{sh}, in cm^2, at any position along their span are not to be less than the values obtained from the following formulae:

$$w = \frac{f_{cb} P_I f_p \ell^2 s}{m R_{eH}} 10^3$$

$$A_{sh} = 10 \frac{\sqrt{3} Q_I}{0,9 R_{eH}}$$

where:

f_{cb} : Correction factor for the bending moment at the ends and considering the patch load, taken as:

$$f_{cb} = 3 f_p^3 - 8 f_p^2 + 6 f_p$$

P_I : Any impact pressure defined in the Rules, including:

- bottom impact pressure, as defined in Ch 8, Sec 1, [3.2]
- bow impact pressure, as defined in Ch 8, Sec 1, [4.2]
- dynamic impact pressure, as defined in Ch 5, Sec 6, [2.5]
- stern impact pressure, as defined in Ch 8, Sec 2, [4.2]

f_p : Patch load modification factor, taken as:

$$f_p = \frac{\ell_I}{\ell}$$

Q_I : Shear force, in kN, taken as:

$$Q_I = f_{cs} f_{dist} P_I \ell_I b_I$$

ℓ_I : Extent of impact load area, in m, along the span:

$$\ell_I = \sqrt{A_I}$$

not to be taken greater than:

- 0,5 ℓ for the calculation of Q_I
- ℓ for the calculation of f_p

f_{cs} : Correction factor for the proportion of patch load acting on a single primary supporting member, taken as:

$$f_{cs} = 0,5(f_p^3 - 2 f_p^2 + 2)$$

f_{dist} : Coefficient for shear force distribution along the span, as defined in Fig A

b_I : Breadth of impact area supported by primary supporting member, in m, taken as:

$$b_I = \sqrt{A_I}$$

not to be taken greater than s

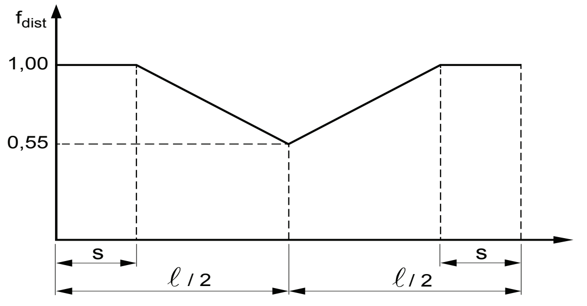
$A_I = 1,1\ L\ B\ C_B\ 10^{-3}$

For complex arrangements of primary supporting members, especially where grillage effect may not be ignored, the greatest shear force, Q_I, at any location along the span of each primary supporting member is to be derived by direct calculations in accordance with Tab A.

Ch 7, Sec 3 (Amendments January 2015)

Insert the following Figure A:

Figure A : Distribution of f_{dist} along the span of simple primary supporting members



Ch 7, Sec 3 (Amendments July 2015)

Replace (new) Table A (from amendments January 2015) by:

Table A : Direct calculation methods for derivation of Q_l

Type of analysis	Model extent	Assumed end fixity
Isolated beam model **(1)**	Overall span of members between effective bending supports	Fixed at ends
Grillage	Longitudinal extent to cover at least 3 primary member spans or spacings Transverse extent to cover at least 3 primary member spans or spacings	Longitudinal and transversal members to be fixed at model boundaries
(1) The envelope of greatest shear force along the span of primary members is to be derived by applying the load Q_l on a square area A_l to a number of locations along the span.		

Ch 7, App 1, Symbols (Amendments July 2015)

Add the following definitions of φ_1 and φ_2:

φ_1 : Coefficient for pressure on exposed decks, as defined in Tab 8

φ_2 : Coefficient taken equal to:

- $\varphi_2 = 1$ for $L \geq 120$ m
- $\varphi_2 = L/120$ for $L < 120$ m

Ch 7, App 1, Table 3 (Amendments July 2015)

Replace the row "Sides above the waterline" in Table 3 by:

Table 3 : Wave pressure in upright ship conditions (load cases "a" and "b")

Location	Wave pressure p_W, in kN/m²	
	crest	trough **(1)**
Sides above the waterline ($z > T_1$)	$\rho g(T_1 + C_{F1}\alpha^{1/4}h_1 - z)$ without being taken, for case "a" only, less than 0,15 φ_1 φ_2 L	0,0

Ch 7, App 1, Table 4 (Amendments July 2015)

Replace the row "Sides above the waterline" in Table 4 by:

Table 4 : Wave pressure in inclined ship conditions (load cases "c" and "d")

Location	Wave pressure p_W, in kN/m² (negative roll angle) **(1)**	
	$y \geq 0$	$y < 0$
Sides above the waterline ($z > T_1$)	$\rho g \left[T_1 + C_{F2} \alpha^{1/4} \left(\frac{y}{B_W} h_1 + A_R y \right) - z \right]$ without being taken, for case "c" only, less than $0{,}15\ \varphi_1\ \varphi_2\ L$	0,0

Ch 7, App 1 (Amendments July 2015)

Insert the following Table 5:

Table 5 : Coefficient φ_1

Exposed deck location	φ_1
Freeboard deck and below	1,00
Top of lowest tier	0,75
Top of second tier	0,56
Top of third tier	0,42
Top of fourth tier	0,32
Top of fifth tier	0,25
Top of sixth tier	0,20
Top of seventh tier	0,15
Top of eighth tier and above	0,10

Ch 7, App 1, Figure 4 (Amendments July 2015)

Replace "FINE MESH" by "STANDARD MESH" in Figure 4.

Ch 7, App 1, [2.2.1], [3.3.1] and [3.3.2] (Amendments July 2015)

Replace "fine mesh" by "standard mesh" in requirement [2.2.1].

Replace "fine mesh" by "standard mesh" in the first paragraph and in the first item of bullet list of requirement [3.3.1].

Replace "fine mesh" by "standard mesh" in requirement [3.3.2].

Ch 7, App 1, [3.4] (Amendments July 2015)

Replace the title of requirements [3.4.3] and [3.4.4] by:

3.4.3 Standard mesh

3.4.4 Fine mesh for the analysis of structural details

Ch 7, App 1 (Amendments July 2015)

Replace the title of Article [6] by:

6 Buckling assessment based on standard mesh element model

Ch 7, App 1, [7.1.3] and [7.2.1] (Amendments July 2015)

Replace "very fine mesh" by "fine mesh" in the first paragraph of requirement [7.1.3].

Replace "very fine mesh" by "fine mesh" in the first paragraph of requirement [7.2.1] (twice).

Ch 7, App 1, [7.3.1] (Amendments July 2015)

Replace "fine mesh" by "standard mesh" in requirement [7.3.1].

Ch 7, App 2, [2.1.1] (Amendments July 2015)

Replace "fine mesh" by "standard mesh" in the second paragraph of requirement [2.1.1].

Ch 7, App 3, [2.3.1] and [2.3.2] (Amendments July 2015)

Replace "fine mesh" by "standard mesh" in the first, third and fourth paragraphs of requirement [2.3.1].

Replace "fine mesh" by "standard mesh" in requirement [2.3.2].

Ch 7, App 3, Table 1 (Amendments July 2015)

Replace the title of Table 1 by:

Table 1 : Areas to be analysed through standard mesh models

Ch 8, Sec 1, [3.2.1] (Amendments January 2015)

Replace the definition of coefficient C_1 by:

C_1 : Coefficient defined as follows:

- general case:

$$C_1 = \frac{119 - 2300\frac{T_F}{L}}{78 + 1800\frac{T_F}{L}}$$

without being taken greater than 1,0

- for non-propelled units:

$$C_1 = \frac{119 - 2300\frac{T_F}{L}}{156 + 3600\frac{T_F}{L}} + 0,09$$

without being taken greater than 0,59

Ch 8, Sec 1, [3] (Amendments January 2015)

Delete sub-article [3.3] and replace sub-article [3.4] by:

3.4 Scantling

3.4.1 Plating

The net thickness t, in mm, of the hull envelope plating is to be not less than the value obtained from the formula given in *(new)* Ch 7, Sec 1, [3.6.1].

3.4.2 Ordinary stiffeners

The net plastic section modulus Z_{pl} , in cm^3, as defined in Ch 4, Sec 3, [3.4.3] and the net web thickness t_w , in mm, of longitudinal or transversal ordinary stiffeners are not to be less than the values obtained from the formulae given in *(new)* Ch 7, Sec 2, [3.10.1].

3.4.3 Primary supporting members

The net shear area A_{sh} , in cm^2, of primary supporting members at any position along their span is not to be less than the value obtained from the formula given in *(new)* Ch 7, Sec 3, [6.1.1].

3.4.4 Tapering

Outside the flat bottom forward area, scantlings are to be gradually tapered so as to reach the values required for the areas considered.

Ch 8, Sec 1, [4] (Amendments January 2015)

Delete sub-article [4.3] and replace sub-article [4.4] by:

4.4 Scantling

4.4.1 Plating

The net thickness t, in mm, of the hull envelope plating is to be not less than the value obtained from the formula given in *(new)* Ch 7, Sec 1, [3.6.1].

4.4.2 Ordinary stiffeners

The net plastic section modulus Z_{pl} , in cm^3, as defined in Ch 4, Sec 3, [3.4.3] and the net web thickness t_w , in mm, of longitudinal or transversal ordinary stiffeners are not to be less than the values obtained from the formulae given in *(new)* Ch 7, Sec 2, [3.10.1].

4.4.3 Primary supporting members

The net shear area A_{sh} , in cm^2, of primary supporting members at any position along their span is not to be less than the value obtained from the formula given in *(new)* Ch 7, Sec 3, [6.1.1].

4.4.4 Tapering

Outside the bow flare area, scantlings are to be gradually tapered so as to reach the values required for the areas considered.

4.4.5 Intercostal stiffeners

Intercostal stiffeners are to be fitted at mid-span where the angle between the stiffeners and the attached plate is less than 70°.

Ch 8, Sec 1, Table 7, Table 10 and Table 11

*Replace, in row “Plating”, column “Minimum value” of Table 7, Table 10 and Table 11, the first sentence by “Net minimum thickness, in mm **(1)**:”.*

*Add the following footnote **(1)** in Table 7, Table 10 and Table 11:*

(1)	L need not be taken greater than 300 m.

Ch 8, Sec 1 (Amendments January 2015)

Delete Table 12, Table 13, Table 14 and Table 15.

Ch 8, Sec 2, [4.1] (Amendments July 2015)

Replace requirement [4.1.1] by:

4.1.1 Application

Requirements of this Article apply to ships with the service notations **Container ship**, **Passenger ship** or **Liquefied gas carrier**, and having a length L at least equal to 170m. However, for ships with other service notations and shorter length, the Society may require reinforcements of the flat aft on a case by case basis.

Ch 8, Sec 2, [4.1.2] (Amendments January 2015)

Replace the second paragraph of requirement [4.1.2] by:

The scantling pressure defined in [4.2.1] is to be applied to flat areas of the bottom aft having a maximum deadrise angle of 30° and located at a distance not greater than h_{SI} from the design waterline.

Ch 8, Sec 2, [4.2.1]

Replace "T" by "T_1" in the formula of P_{Sl}. (Amendments January 2015)

Add the following definition of T_1 at the end of requirement [4.2.1]: (Amendments January 2015)

Replace the definition of h_{Sl} and h_1 in requirement [4.2.1] by:

T_1 : Draught as defined in Part B, Chapter 5, Symbols.

$h_{Sl} = h_1$

h_1 : Reference value of the relative motion in the upright ship condition, in m, defined in Ch 5, Sec 3, Tab 5, and calculated with the reference value, for x = 0,5 L, taken equal to:

$h_{1,M} = 0,67\ n\ C\ (C_B + 0,7)$, without being taken greater than the minimum of T_1 and $D - 0,9\ T$

Ch 8, Sec 2, [4] (Amendments January 2015)

Replace sub-article [4.3] by:

4.3 Scantling

4.3.1 Plating

The net thickness t, in mm, of the hull envelope plating is to be not less than the value obtained from the formula given in *(new)* Ch 7, Sec 1, [3.6.1].

4.3.2 Ordinary stiffeners

The net plastic section modulus Z_{pl}, in cm³, as defined in Ch 4, Sec 3, [3.4.3] and the net web thickness t_w, in mm, of longitudinal or transversal ordinary stiffeners are not to be less than the values obtained from the formulae given in *(new)* Ch 7, Sec 2, [3.10.1].

4.3.3 Primary supporting members

The net shear area A_{sh}, in cm², of primary supporting members at any position along their span is not to be less than the value obtained from the formula given in *(new)* Ch 7, Sec 3, [6.1.1].

Ch 8, Sec 3, [8.1] (Amendments July 2015)

Replace requirements [8.1.2], [8.1.3] and [8.1.4] by:

8.1.2 Seating supporting structure

Seatings are to be supported by transversal and longitudinal members welded to a bed plate. The supporting structure may be integral with the bottom structure (integrated directly in the floors and girders).

Transverse and longitudinal members supporting the seatings are to be located in line with floors and double or single bottom girders, respectively.

They are to be so arranged as to avoid discontinuity and ensure sufficient accessibility for welding of joints and for surveys and maintenance.

8.1.3 Supporting structure included in the double bottom structure

Where large internal combustion engines or turbines plants are fitted, supporting members are to be integral with the double bottom structure. Longitudinal members supporting the bedplates in way of seatings are to be aligned with double bottom girders and are to be extended aft in order to form girders for thrust blocks.

The longitudinal members in way of seatings are to be continuous from the bedplates to the bottom shell.

8.1.4 Supporting structure above the double bottom plating

Where the supporting structure is situated above the double bottom plating, the girders in way of seatings are to be fitted with flanged brackets, generally located at each frame and extending towards both the centre of the ship and the sides.

The extension of the seatings above the double bottom plating is to be limited as far as practicable while ensuring adequate spaces for the fitting of bedplate bolts. Bolt holes are to be located such that they do not interfere with supporting structures.

Replace requirement [8.1.6] by:

8.1.6 Number of longitudinal members in way of seatings of engines

In general, at least two longitudinal members are to be fitted in way of seatings of main engines.

One longitudinal member may be fitted only where the following three formulae are complied with:

$L < 150$ m

$P < 7100$ kW

$P < 2{,}3\ n_R\ L_E$

Ch 8, Sec 3 (Amendments July 2015)

Replace Table 3 by:

Table 3 : Scantlings of the structural elements in way of seatings of engines

Scantling	Minimum value
Net cross-sectional area, in cm², of each bedplate of the seatings	$40 + 70\dfrac{P}{n_r L_E}$
Net thickness, in mm, of each bedplate of the seatings	• Bedplate supported by two or more longitudinal members: $\sqrt{240 + 175\dfrac{P}{n_r L_E}}$ • Bedplate supported by one longitudinal member: $5 + \sqrt{240 + 175\dfrac{P}{n_r L_E}}$
Web net thickness, in mm, of girders fitted in way of each bedplate of the seatings	• Bedplate supported by two or more longitudinal members: $\dfrac{1}{n_G}\sqrt{320 + 215\dfrac{P}{n_r L_E}}$ where n_G is the number of longitudinal members in way of the bedplate considered • Bedplate supported by one longitudinal member: $\sqrt{95 + 65\dfrac{P}{n_r L_E}}$
Web net thickness, in mm, of transverse members fitted in way of bedplates of the seating **(1)**	$\sqrt{55 + 40\dfrac{P}{n_r L_E}}$
(1) When intermediate transverse members welded to the bedplate are fitted, the web minimum net thickness may be reduced on a case-by-case basis.	

Ch 8, Sec 4, [2.2.2] (Amendments July 2015)

Replace the formula of "p" and add the definition of "n", as follows:

$p = 10\ n\ a\ c\ [b\ f - (z - T)]$

n : Navigation coefficient, defined in Ch 5, Sec 1, [2.6]

Ch 8, Sec 6, [1.1] (Amendments July 2015)

Replace requirement [1.1.1] by:

1.1.1 The requirements of this Section apply to the arrangement, strength and securing of side doors located abaft the collision bulkhead, and of stern doors leading to enclosed spaces and dedicated to loading/unloading of cargo and vehicles.

The requirements apply to ships engaged on international voyages and also to ships engaged only in domestic (non-international) voyages, except where specifically indicated otherwise in this section.

Small shell doors not covered by this Section are dealt with in Ch 8, Sec 12.

Ch 8, Sec 10, [3.3.3] (Amendments July 2015)

Replace the first paragraph of requirement [3.3.3] by:

The windows and sidescuttles assessment methodology defined in this Article is equivalent to Standard ISO 21005:2004.

Ch 8, Sec 10, [3.3.4] (Amendments July 2015)

Replace the definition of R_m by:

R_m : Guaranteed minimum flexural strength, in N/mm², of material used. For guidance only, the guaranteed minimum flexural strength R_m for glass window is:

- for glass thermally tempering (toughened): R_m = 150 N/mm²
- for glass chemically toughened: R_m = 200 N/mm²

Ch 8, Sec 10, [6.3] (Amendments January 2015)

Replace requirement [6.3.1] by:

6.3.1 Freeing port area for continuous trunk or continuous hatchway coaming

The freeing port area in the well contiguous to substantially continuous trunk/hatchway coaming is to be not less than:

- that obtained from Tab 5, where the trunk/hatchway coaming is not included in the freeboard calculation
- 33% of the bulwark area where the trunk/hatchway coaming meets the conditions of the International Convention on Load Lines in force and is included in the freeboard calculation.

Ch 8, Sec 10 (Amendments January 2015)

Replace Table 5 by:

Table 5 : Freeing port area in a well contiguous to a continuous trunk or hatchway

Breadth B_H, in m, of hatchway or trunk	Area A_2, in m², of freeing ports
$B_H \le 0,4B$	$0,2\,\ell_B h_B\left(\dfrac{h_S}{2h_W}\right)$
$0,4B < B_H \le 0,75B$	$\left[0,2-0,286\left(\dfrac{B_H}{B}-0,4\right)\right]\ell_B h_B\left(\dfrac{h_S}{2h_W}\right)$
$B_H \ge 0,75B$	$0,1\,\ell_B h_B\left(\dfrac{h_S}{2h_W}\right)$

Note 1:

ℓ_B : Length, in m, of bulwark in a well at one side of the ship

h_B : Mean height, in m, of bulwark in a well of length ℓ_B

h_S : Standard superstructure height, in m, defined in [1.2.1]

h_W : Distance, in m, of the well deck above the freeboard deck, to be taken not less than 0,5 h_S.

Ch 8, Sec 10, [6.4.2] (Amendments January 2015)

Replace the definition of h_S and h_W at the end of requirement [6.4.2] by:

h_S, h_W : As defined in Tab 5.

Ch 8, Sec 10, [6.4.3] (Amendments January 2015)

Delete the definition of c_{SH} , h_S and h_W in requirement [6.4.3].

Chapter 8 (Amendments July 2015)

Add the following Section 12:

SECTION 12 WATERTIGHT AND WEATHERTIGHT DOORS

1 General

1.1 Application

1.1.1 The requirements of this Section apply to the scantling of small shell doors and doors in bulkheads that are required to be watertight or weathertight.

1.2 Definitions

1.2.1 Watertightness

The various degrees of watertightness are defined in Ch 3, Sec 3, [3.3.2].

1.2.2 Securing device

A securing device is a device used to keep the door closed by preventing it from rotating about its hinges, or from sliding open.

1.2.3 Supporting device

A supporting device is a device used to transmit external or internal loads from the door to a securing device and from the securing device to the ship's structure, or a device other than a securing device, such as a hinge, stopper or other fixed device, which transmits loads from the door to the ship's structure.

1.2.4 Locking device

A locking device is a device locking the securing device in the closed position.

2 Design loads

2.1 General

2.1.1 Doors are to be designed to offer equivalent strength compared to the adjacent bulkhead in which they are fitted. Therefore, they are to be assessed considering the same design loads, as per the examples given in the following requirements.

2.2 Side shell doors

2.2.1 Doors fitted in side shell are to be checked with the outside sea pressures defined in Ch 5, Sec 5, and whenever relevant, with the internal flooding pressure defined in Ch 5, Sec 6, [9].

2.3 Internal bulkheads doors

2.3.1 Doors fitted in watertight bulkheads are to be checked with the flooding pressures defined in Ch 5, Sec 6, [9] for spaces on both sides of the bulkhead.

2.4 Superstructure doors

2.4.1 Doors fitted in superstructure walls are to be checked with the loads defined in Ch 8, Sec 4, [2].

3 Door leaf scantling

3.1 Plating

3.1.1 The net thickness of watertight and weathertight doors is to be not less than that calculated according to Ch 7, Sec 1, [3.5] or to Ch 8, Sec 4, [3], as relevant.

3.2 Stiffeners

3.2.1 The net scantling of doors stiffeners is to be not less than that calculated according to Ch 7, Sec 2 or to Ch 8, Sec 4, [4], as relevant, considering that doors stiffeners are generally to be considered as simply supported at ends instead of clamped.

3.3 Glass

3.3.1 If permitted, when glazing is fitted in the door leaf, its thickness is to be in line with the requirements of Ch 8, Sec 10, [3.3].

4 Securing and supporting

4.1 General

4.1.1 Doors are to be fitted with adequate means of securing and supporting so as to be commensurate with the strength and stiffness of the surrounding structure.

The hull supporting structure in way of the doors is to be suitable for the same design loads and design stresses as the securing and supporting devices.

Where packing is required, the packing material is to be of a comparatively soft type, and the supporting forces are to be carried by the steel structure only. Other types of packing may be considered by the Society on a case by case basis.

In order to prevent damage to the packing material, the edges of the part of the door frame in contact with the seal should be rounded or chamfered.

The maximum design clearance between securing and supporting devices is generally not to exceed 3 mm.

4.1.2 Only the active supporting and securing devices having an effective stiffness in the relevant direction are to be included and considered to calculate the reaction forces acting on the devices. Small and/or flexible devices such as cleats intended to provide local compression of the packing material may generally not be included in the calculation in [4.2].

The number and distribution of securing and supporting devices is to be set to achieve the scantling criteria in [4.2] and the required degree of watertightness.

4.2 Scantlings

4.2.1 Securing and supporting devices are to be adequately designed so that they can comply with the checking criteria defined in Ch 7, Sec 3, [3.6.1] for primary members, using general or flooding partial safety factors as relevant.

4.2.2 In addition to the requirements in [4.2.1], every element transmitting loads by means of direct contact must be checked against bearing. In that respect, the maximum normal compressive stress σ_c distributed over the contact area between the two elements is not to be higher than R_{eH}.

4.2.3 The distribution of the reaction forces acting on the securing and supporting devices is generally to be supported by direct calculations taking into account the flexibility of the hull structure, the actual position of the supports and the design load pattern. In case of homogeneously distributed supports and uniform design pressure, the total force acting on the door may be considered as evenly divided amongst the supports.

4.2.4 All load transmitting elements in the design load path, from the door through securing and supporting devices into the ship's structure, including welded connections, are to be of the same strength standard as required for the securing and supporting devices. These elements include pins, support brackets and back-up brackets.

5 Inspection and testing

5.1 General

5.1.1 Watertight and semi-watertight doors which become immersed by an equilibrium or intermediate waterplane are to be subjected to a hydrostatic pressure test.

5.1.2 For large doors intended for use in the watertight subdivision boundaries of cargo spaces, structural analysis may be accepted in lieu of pressure testing. Where such doors utilize gasket seals, a prototype pressure test to confirm that the compression of the gasket material is capable of accommodating any deflection, revealed by the structural analysis, is to be carried out.

5.1.3 Watertight doors which are not immersed by an equilibrium or intermediate waterplane but become intermittently immersed at angles of heel in the required range of positive stability beyond the equilibrium position may be only hose tested (required only to be weathertight according to Ch 3, Sec 3, [3.3.2].

5.2 Hydrostatic pressure testing

5.2.1 The head of water used for the pressure test shall correspond at least to the head measured from the lower edge of the door opening, at the location in which the door is to be fitted in the vessel, to the bulkhead deck or freeboard deck, as applicable, or to the most unfavourable damage waterplane, if that be greater. Testing may be carried out at the factory or other shore based testing facility prior to installation in the ship. The duration of the test is to be at least 30 min.

5.2.2 Leakage criteria for watertight doors

The following acceptable leakage criteria should apply:

- doors with gaskets: no leakage
- doors with metallic sealing: max leakage 1 litre/min.

Limited leakage may be accepted for pressure tests on large doors located in cargo spaces employing gasket seals or guillotine doors located in conveyor tunnels, in accordance with the following value, in litre/min:

$$\frac{(P + 4.572) \times h^2}{6568}$$

where:

P : Perimeter of door opening (m)

h : Test head of water (m).

However, in the case of doors where the water head taken for the determination of the scantling does not exceed 6,10 m, the leakage rate may be taken equal to 0,375 litre/min if this value is greater than that calculated by the above-mentioned formula.

5.2.3 Leakage criteria for semi-watertight doors

A leakage quantity of approximately 100 l/hour is to be considered as being acceptable for a 1,35 m^2 opening.

5.2.4 For doors on passenger ships which are normally open and used at sea or which become submerged by the equilibrium or intermediate waterplane, a prototype test shall be conducted, on each side of the door, to check the satisfactory closing of the door against a force equivalent to a water height of at least 1m above the sill on the centre line of the door.

5.3 Hose testing

5.3.1 All watertight, semi-watertight and weathertight doors shall be subject to a hose test after installation in a ship. Hose testing is to be carried out:

- from both sides of a watertight or semi-watertight door unless, for a specific application, exposure to floodwater is anticipated only from one side
- from both sides of internal bulkheads weathertight doors (fitted above bulkhead deck)
- from the exposed side of external weathertight doors (superstructures).

Where a hose test is not practicable because of possible damage to machinery, electrical equipment insulation or outfitting items, it may be replaced by means such as an ultrasonic leak test or an equivalent test.

6 Type approval procedure

6.1 General

6.1.1 Type approval certificates of doors may be issued to applicant manufacturers to certify that the design of the door has been assessed against a given strength level.

6.1.2 The documents and information listed in [6.2.1] must allow for the door strength to be checked against the applied design load.

6.1.3 In case a type approved door is fitted onboard a vessel, the hull supporting structure in way of the door is to be checked to have adequate strength according to [4].

6.1.4 A type approved door fitted onboard a vessel is to be selected to have a design load at least equivalent to the adjacent bulkhead in which it is fitted.

6.2 Documents and information to be submitted

6.2.1 Prior to issuance of type approval certificate, the following documents and information must be submitted to the Society for review, for each door model and variant:

- maximum considered design load
- tightness level (weathertight, semi-watertight or watertight)
- door dimensions
- structural drawings of the door, including securing devices
- material and mechanical properties of each part of the door
- test and inspection procedure (if relevant, see [6.3]).

6.3 Prototype test

6.3.1 Upon manufacturer's request, it is possible to carry out the tests required for watertight and semi-watertight doors in [5.2] on a single prototype door. The related test reports are then annexed to the type approval certificate.

6.3.2 In such a case, the test procedure is to be submitted to the Society for review and shall be in line with the relevant requirements in [5].

Ch 8, *(new)* Sec 12, [5.1.2]

Replace the beginning of (new) requirement [5.1.2] by "For large doors of more than 6 m^2 intended ...".

Ch 9, Sec 1, [11.6] (Amendments July 2015)

Replace requirement [11.6.3] by:

11.6.3 Strength check

It is to be checked that the Von Mises equivalent stress σ_E in primary supporting members, calculated, in N/mm^2, for the load cases defined in [11.6.2], is in compliance with the following formula:

$\sigma_E \le \sigma_{ALL}$

where:

σ_{ALL} : Allowable stress, in N/mm^2, to be taken equal to 0,55 R_{eH}

R_{eH} : Minimum yield stress, in N/mm^2, of the specified steel. R_{eH} is not to exceed the lower of 0,7 R_m and 450 N/mm^2

R_m : Minimum ultimate tensile strength, in N/mm^2, of the steel used.

When the loads are calculated for crash stop of the ship, the criteria given in [11.6.4] are to be complied with.

When fine mesh finite element analysis (typically 50x50 mm) is used for the calculation of stresses, then the following criteria may be applied:

- for elements not adjacent to the weld:

  $\sigma_E \le 1,53\ \sigma_{ALL}$

- for elements adjacent to the weld:

  $\sigma_E \le 1,34\ \sigma_{ALL}$

Ch 9, Sec 1, [11.6.4] and [11.7.4] (Amendments July 2015)

Replace "σ_{CRASH} = 1,2 σ_{ALL}" by "σ_{CRASH} = 1,25 σ_{ALL}" in requirements [11.6.4] and [11.7.4].

Replace "very fine mesh" by "fine mesh".

Ch 9, Sec 1, [11.7.3] (Amendments July 2015)

Replace "very fine mesh" by "fine mesh" in requirement [11.7.3].

Ch 9, Sec 4, [3] (Amendments July 2015)

Replace sub-article [3.5] by:

3.5 Windlass

3.5.1 General

The Rule Note NR626 Anchor Windlass is to be applied, considering the windlass brake capacity defined in [3.5.2].

3.5.2 Brake capacity

Based on mooring line arrangements with brakes engaged and cable lifter disengaged, the capacity HL (Holding Load), in kN, of the windlass brake is to be sufficient to withstand the following loads without any permanent deformation of the stressed parts and without brake slip:

- 0,8 times the breaking load BL of the chain, if not combined with a chain stopper
- 0,2 times the breaking load BL of the chain, if combined with a chain stopper.

Ch 9, Sec 4, [4.2.2]

Add the following item at the end of list in requirement [4.2.2]

- **LNG bunkering ship**

Ch 9, Sec 4, [4.9.7] and [4.10.7] (Amendments July 2015)

Replace "fine mesh" by "standard mesh" in the last paragraph of requirements [4.9.7] and [4.10.7].

Ch 9, Sec 4, [5.2.1] (Amendments July 2015)

Replace the second paragraph of requirement [5.2.1] by:

The towlines having the characteristics defined in Tab 7 are intended as those belonging to the ship to be towed by a tug or another ship under normal towing conditions (calm water / harbour).

Ch 9, Sec 4, Table 7 (Amendments July 2015)

Add “300” in the 3rd column of Table 7, from line “6100 < EN ≤ 6500” to line “14600 < EN ≤ 16000”.

Add “1471” in the 4th column of Table 7, from line “6100 < EN ≤ 6500” to line “14600 < EN ≤ 16000”.

Ch 10, Sec 2, [2.2]

Add the following requirements [2.2.4] and [2.2.5]:

2.2.4 Bulk carriers, ore carriers or combination carriers less than 150 m in length

Ships with one of the service notation **bulk carrier**, **ore carrier ESP** or **combination carrier ESP** , and less than 150 m in length, are to be provided with an approved computer-based loading instrument in accordance with the applicable requirements of this Section. The approved loading instrument is to be capable of providing information on the ship's stability in the intact condition.

2.2.5 Oil tankers and chemical tankers

Ships with one of the service notation **oil tanker ESP**, or **chemical tanker**, are to be provided with an approved computer-based loading instrument in accordance with the applicable requirements of this Section.The approved loading instrument is to be capable of verifying compliance with the intact and applicable damage stability requirements. Exemptions may be granted on a case by case basis.

Ch 11, Sec 1, [2.3.4] (Amendments July 2015)

Replace the paragraph “For connections of longitudinal ... intermittent welding.” by:

One side continuous welding may be accepted instead of chain and staggered intermittent welding for connections of stiffeners in the dry spaces of deckhouses and superstructures, where not affected by sea pressure, tank pressure or concentrated loads.

Ch 11, Sec 1, [2.3.5]

Replace the two bullet lists, their introducing sentence, and the sentence just after, in requirement [2.3.5], by:

Whether the welds are continuous or intermittent, the throat thickness of the fillet welds is not to be less than, as a rule:

- 3,0 mm, for plating thickness of less than 6 mm
- 3,5 mm, otherwise.

In the case of automatic or semi-automatic deep penetration weld, the throat thickness (the minimum values included) may be reduced according to [2.3.9].

Ch 11, Sec 1, Table 2

*Delete footnote **(5)** in Table 2 and its reference in row “Deck” (connection of strength deck to side plating).*

Ch 11, Sec 1, [2.3.8]

Replace the first paragraph of requirement [2.3.8] by:

The throat thickness t_T of fillet welds connecting ordinary stiffeners and collar plates, if any, to the web of primary supporting members is to be not less than the value obtained, in mm, from the following formula:

$t_T = 0,27\ f_{yd}\ t_w + 0,7\ g$

where:

f_{yd} : Correction factor taking into account the yield strength of the weld deposit:

$$f_{yd} = \left(\frac{1}{k}\right)^{0,5}\left(\frac{235}{\sigma_{weld}}\right)^{0,75}$$

without being taken less than 0,707

σ_{weld} : Minimum yield stress of the weld deposit. σ_{weld} is not to be less than:

- 305 N/mm^2 for welding of normal strength steels
- 375 N/mm^2 for welding of higher strength steels having a yield strength from 265 to 355 N/mm^2
- 400 N/mm^2 for welding of higher strength steels having a yield strength of 390 N/mm^2

k : Material factor of the steel used, defined in Ch 4, Sec 1, [2.3]

t_w : Web gross thickness, in mm

g : Allowance for fillet weld gap, to be taken equal to 2 mm, unless otherwise specified.

Further requirements are specified in Ch 11, Sec 2.

Ch 11, Sec 3

Replace Article [1] by:

1 Testing procedures of watertight compartments

1.1 Application

1.1.1 These test procedures are to confirm the watertightness of tanks and watertight boundaries, and the structural adequacy of tanks forming a part of the watertight subdivisions of ships. These procedures may also be applied to verify the weathertightness of structures and shipboard outfitting.

The tightness of all tanks and watertight boundaries of ships during new construction and ships relevant to major conversions or major repairs is to be confirmed by these test procedures prior to the delivery of the ships.

Note 1 : Major repair means a repair affecting structural integrity.

1.1.2 All gravity tanks and other boundaries required to be watertight or weathertight are to be tested in accordance with these procedures and proven to be tight and structurally adequate as follows:

- gravity tanks for their tightness and structural adequacy
- watertight boundaries other than tank boundaries for their watertightness
- weathertight boundaries for their weathertightness.

Note 1 : Gravity tank means a tank that is subject to vapour pressure not greater than 70 kPa.

1.1.3 The testing of structures not listed in Tab 2 or Tab 3 is to be specially considered by the Society.

1.2 General

1.2.1 Tests are to be carried out in the presence of a Surveyor at a stage sufficiently close to the completion of work, with all the hatches, doors, windows, etc., installed and all the penetrations including pipe connections fitted, and before any ceiling and cement work is applied over the joints. Specific test requirements are given in [1.6] and Tab 2. For the timing of the application of coating and the provision of safe access to joints, see [1.7], [1.8] and Tab 4.

1.3 Definitions

1.3.1 Structural test

A structural test is a test to verify the structural adequacy of tank construction. This may be a hydrostatic test or, where the situation warrants, a hydropneumatic test.

1.3.2 Leak test

A leak test is a test to verify the tightness of a boundary. Unless a specific test is indicated, this may be a hydrostatic/hydropneumatic test or an air test. A hose test may be considered to be an acceptable form of leak test for certain boundaries, as indicated by footnote (3) of Tab 2.

1.3.3 Each type of structural and leak tests is defined in Tab 1.

1.4 Structural test procedures

1.4.1 Type and time of test

Where a structural test is specified in Tab 1 or Tab 2, a hydrostatic test in accordance with [1.6.1] is acceptable. Where practical limitations (strength of building berth, light density of liquid, etc.) prevent the performance of a hydrostatic test, a hydropneumatic test in accordance with [1.6.2] may be accepted instead.

A hydrostatic or hydropneumatic test for the confirmation of structural adequacy may be carried out while the ship is afloat, provided the results of a leak test are confirmed to be satisfactory before the ship is set afloat.

1.4.2 Testing schedule for new construction and major structural conversion or repair

a) The tank boundaries are to be tested from at least one side. The tanks for the structural test are to be selected so that all the representative structural members are tested for the expected tension and compression.

b) On each ship, structural tests are to be carried out on at least one tank among a group of tanks having a structural similarity (i.e. same design conditions, alike structural configurations with only minor localised differences considered to be acceptable by the attending Surveyor), provided all the other similar tanks are tested for leaks by means of an air test.

   The acceptance of a leak test (air test) instead of a structural test does not apply to boundaries of:

   - cargo spaces adjacent to compartments which are not cargo spaces, for tankers and combination carriers, or
   - segregated cargo tanks or pollutant cargo tanks, for the other types of ships.

c) Additional tanks may require a structural test, as deemed necessary after the structural test of the first tank.

d) Where structural adequacy of the tanks of a ship was verified by structural testing as defined in Tab 1, the subsequent ships in the series (i.e. sister ships built from the same plans, at the same shipyard) may be exempted from the tank structural test, provided that:

   - watertightness of the boundaries of all the tanks is verified by leak tests, and thorough inspections are carried out
   - structural testing is carried out for at least one tank of each type among all the tanks of each sister ship.

     Note 1: The provisions of item b) are to be applied instead of these provisions in case of boundaries of:

     - cargo spaces adjacent to compartments which are not cargo spaces, for tankers and combination carriers, or
     - segregated cargo tanks or pollutant cargo tanks, for the other types of ships.

   - additional tanks may require a structural test, as deemed necessary after the structural test of the first tank, or at the request of the attending Surveyor.

e) Sister ships built (i.e. keel laid) two years or more after the delivery of the last ship of the series may be tested in accordance with item d), at the discretion of the Society, provided that:

   - general workmanship has been maintained (i.e. no discontinuity of shipbuilding, no significant changes in the construction methodology or technology at the yard, and shipyard personnel appropriately qualified and demonstrating an adequate level of workmanship as determined by the Society), and
   - an enhanced NDT programme is implemented for the tanks not subject to the structural test.

f) The watertight boundaries of spaces other than tanks may be exempted from the structural test, provided that the boundary watertightness of the exempted spaces is verified by leak tests and inspections. The tank structural test is to be carried out and the requirements from item a) to item e) are to be applied for ballast holds, chain lockers, and for a representative cargo hold in case of cargo holds intended for in-port ballasting.

1.5 Leak test procedures

1.5.1 For the leak tests specified in Tab 2, tank air tests, compressed air fillet weld tests and vacuum box tests, in accordance respectively with [1.6.4], [1.6.5] and [1.6.6], or their combinations, are acceptable. Hydrostatic or hydropneumatic tests may be also accepted as leak tests, provided that sub-articles [1.7], [1.8] and [1.9] are complied with. Hose tests, in accordance with [1.6.3], are also acceptable for items 14 to 17 referred to in Tab 2, taking footnote **(3)** into account.

1.5.2 Air tests of joints may be carried out at the block stage, provided that all work on the block that may affect the tightness of a joint is completed before the test. See also [1.7.1] for the application of final coatings, [1.8] for the safe access to joints, and Tab 4 for the summary.

1.6 Test methods

1.6.1 Hydrostatic test

Unless another liquid is approved, hydrostatic tests are to consist in filling the space with fresh water or sea water, whichever is appropriate for testing, to the level specified in Tab 2 or Tab 3.

In case where a tank is intended for cargoes having a density higher than the density of the liquid used for the test, the testing pressure height is to be specially considered.

All the external surfaces of the tested space are to be examined for structural distortion, bulging and buckling, any other related damage, and leaks.

1.6.2 Hydropneumatic test

Hydropneumatic tests, where approved, are to be such that the test condition, in conjunction with the approved liquid level and supplemental air pressure, simulates the actual loading as far as practicable. The requirements and recommendations in [1.6.4] for tank air tests apply also to hydropneumatic tests.

All the external surfaces of the tested space are to be examined for structural distortion, bulging and buckling, any other related damage, and leaks.

1.6.3 Hose test

Hose tests are to be carried out with the pressure in the hose nozzle maintained at least at $2 \cdot 10^5$ Pa during the test. The nozzle is to have a minimum inside diameter of 12 mm and to be at a perpendicular distance from the joint not exceeding 1,5 m. The water jet is to impinge upon the weld.

Where a hose test is not practical because of possible damage to machinery, electrical equipment insulation, or outfitting items, it may be replaced by a careful visual examination of the welded connections, supported where necessary by means such as a dye penetrant test or an ultrasonic leak test, or equivalent.

1.6.4 Tank air test

All boundary welds, erection joints and penetrations including pipe connections are to be examined in accordance with approved procedures and under a stabilized pressure differential above atmospheric pressure not less than $0{,}15 \cdot 10^5$ Pa, with a leak-indicating solution (such as soapy water/detergent or a proprietary solution) applied.

A U-tube having a height sufficient to hold a head of water corresponding to the required test pressure is to be arranged. The cross-sectional area of the U-tube is not to be less than that of the pipe supplying air to the tank. Instead of a U-tube, two calibrated pressure gauges may be acceptable to verify the required test pressure.

A double inspection of the tested welds is to be carried out. The first inspection is to be made immediately upon application of the leak indication solution; the second one is to be made approximately four or five minutes after, in order to detect those smaller leaks which may take time to appear.

1.6.5 Compressed air fillet weld test

In this air test, compressed air is injected from one end of a fillet welded joint, and the pressure verified at the other end of the joint by a pressure gauge. Pressure gauges are to be arranged so that an air pressure of at least $0{,}15 \cdot 10^5$ Pa can be verified at each end of any passage within the portion being tested.

Note 1: Where a leak test is required for fabrication involving partial penetration welds, a compressed air test is also to be carried out in the same manner as to fillet weld where the root face is large, i.e. 6-8 mm.

1.6.6 Vacuum box test

A box (vacuum testing box) with air connections, gauges and an inspection window is placed over the joint with a leak-indicating solution applied to the weld cap vicinity. The air within the box is removed by an ejector to create a vacuum of $0{,}20 \cdot 10^5$ to $0{,}26 \cdot 10^5$ Pa inside the box.

1.6.7 Ultrasonic test

An ultrasonic echo transmitter is to be arranged on the inside of a compartment, and a receiver on the outside. The watertight/weathertight boundaries of the compartment are scanned with the receiver, in order to detect an ultrasonic leak indication. Any leakage in the sealing of the compartment is indicated at a location where sound is detectable by the receiver.

1.6.8 Penetration test

For the test of butt welds or other weld joints, a low surface tension liquid is applied on one side of a compartment boundary or a structural arrangement. If no liquid is detected on the opposite sides of the boundaries after the expiration of a defined period of time, this indicates tightness of the boundaries. In certain cases, a developer solution may be painted or sprayed on the other side of the weld to aid leak detection.

1.6.9 Other tests

Other methods of testing may be considered by the Society upon submission of full particulars prior to the commencement of the tests.

1.7 Application of coating

1.7.1 Final coating

For butt joints welded by means of an automatic process, the final coating may be applied at any time before completion of a leak test of the spaces bounded by the joints, provided that the welds have been visually inspected with care, to the satisfaction of the Surveyor.

The Surveyors reserve the right to require a leak test prior to the application of a final coating over automatic erection butt welds.

For all the other joints, the final coating is to be applied after the completion of the joint leak test. See also Tab 4.

1.7.2 Temporary coating

Any temporary coating which may conceal defects or leaks is to be applied at the same time as for a final coating (see [1.7.1]). This requirement does not apply to shop primers.

1.8 Safe access to joints

1.8.1 For leak tests, a safe access to all the joints under examination is to be provided. See also Tab 4.

1.9 Hydrostatic or hydropneumatic tightness test

1.9.1 In cases where the hydrostatic or hydropneumatic tests are applied instead of a specific leak test, the examined boundaries are to be dew-free, otherwise small leaks are not visible.

Ch 11, Sec 3, [2] (Amendments July 2015)

Delete sub-articles [2.2], [2.3] and [2.5].

Ch 11, Sec 3

Replace Table 1, Table 2, Table 3 and Table 4 by:

Table 1 : Types of test

Test types	Procedure
Hydrostatic test (leak and structural)	The space to be tested is filled with a liquid to a specified head
Hydropneumatic test (leak and structural)	Combination of a hydrostatic test and an air test, the space to be tested being partially filled with liquid and pressurized with air
Hose test (leak)	Tightness check of the joint to be tested by means of a jet of water, the joint being visible from the opposite side
Air test (leak)	Tightness check by means of an air pressure differential and a leak-indicating solution. It includes tank air tests and joint air tests, such as compressed air fillet weld tests and vacuum box tests
Compressed air fillet weld test (leak)	Air test of fillet welded tee joints, by means of a leak indicating solution applied on fillet welds
Vacuum box test (leak)	A box over a joint with a leak indicating solution applied on the welds. A vacuum is created inside the box to detect any leaks
Ultrasonic test (leak)	Tightness check of the sealing of closing devices such as hatch covers, by means of ultrasonic detection techniques
Penetration test (leak)	Check, by means of low surface tension liquids (i.e. dye penetrant test), that no visual dye penetrant indications of potential continuous leakages exist in the boundaries of a compartment

Table 2 : Test requirements for tanks and boundaries

Item	Tank or boundaries to be tested	Test type	Test head or pressure	Remarks
1	Double bottom tanks **(4)**	leak and structural **(1)**	The greater of: • top of the overflow • 2,4 m above top of tank **(2)** • bulkhead deck	
2	Double bottom voids **(5)**	leak	See [1.6.4] to [1.6.6], as applicable	Including pump room double bottom and bunker tank protection double hull required by MARPOL Annex I
3	Double side tanks	leak and structural **(1)**	The greater of: • top of the overflow • 2,4 m above top of tank **(2)** • bulkhead deck	
4	Double side voids	leak	See [1.6.4] to [1.6.6], as applicable	
5	Deep tanks other than those listed elsewhere in this Table	leak and structural **(1)**	The greater of: • top of the overflow • 2,4 m above top of tank **(2)**	
6	Cargo oil tanks	leak and structural **(1)**	The greater of: • top of the overflow • 2,4 m above top of tank **(2)** • top of tank plus setting of any pressure relief valve **(2)**	
7	Ballast holds of bulk carriers	leak and structural **(1)**	The greater of: • top of the overflow • top of cargo hatch coaming	
8	Peak tanks	leak and structural **(1)**	The greater of: • top of the overflow • 2,4 m above top of tank **(2)**	After peak to be tested after installation of stern tube

Item	Tank or boundaries to be tested	Test type	Test head or pressure	Remarks
9	a) Fore peak spaces with equipment	leak	See [1.6.3] to [1.6.6], as applicable	
	b) Fore peak voids	leak and structural **(1) (9)**	To bulkhead deck	After peak to be tested after installation of stern tube
	c) Aft peak spaces with equipment	leak	See [1.6.3] to [1.6.6], as applicable	
	d) Aft peak voids	leak	See [1.6.4] to [1.6.6], as applicable	
10	Cofferdams	leak	See [1.6.4] to [1.6.6], as applicable	
11	a) Watertight bulkheads	leak **(8)**	See [1.6.3] to [1.6.6], as applicable **(7)**	
	b) Superstructure end bulkheads	leak	See [1.6.3] to [1.6.6], as applicable	
12	Watertight doors below freeboard or bulkhead deck	leak **(6) (7)**	See [1.6.3] to [1.6.6], as applicable	
13	Double plate rudder blades	leak	See [1.6.4] to [1.6.6], as applicable	
14	Shaft tunnels clear of deep tanks	leak **(3)**	See [1.6.3] to [1.6.6], as applicable	
15	Shell doors	leak **(3)**	See [1.6.3] to [1.6.6], as applicable	
16	Weathertight hatch covers and closing appliances	leak **(3) (7)**	See [1.6.3] to [1.6.6], as applicable	Hatch covers closed by tarpaulins and battens excluded
17	Dual purpose tank/dry cargo hatch covers	leak **(3) (7)**	See [1.6.3] to [1.6.6], as applicable	In addition to the structural test in item 6 or item 7
18	Chain lockers	leak and structural	Head of water up to top of chain pipe	
19	L.O. sump tanks and other similar tanks/spaces under main engines	leak	See [1.6.3] to [1.6.6], as applicable	
20	Ballast ducts	leak and structural **(1)**	The greater of: • ballast pump maximum pressure • setting of any pressure relief valve	
21	Fuel oil tanks	leak and structural **(1)**	The greater of: • top of the overflow • 2,4 m above top of tank **(2)** • top of tank plus setting of any pressure relief valve **(2)** • bulkhead deck	

(1) See [1.4.2], item a).
(2) The top of a tank is the deck forming the top of the tank, excluding any hatchways.
(3) Hose test may be also considered as a medium of the leak test. See [1.3.2].
(4) Including the tanks arranged in accordance with the provisions of Ch 2, Sec 2, [3.1.4].
(5) Including the duct keels and dry compartments arranged in accordance with the provisions of SOLAS, Regulations II-1/11.2 and II-1/9.4 respectively, and/or the oil fuel tank protection and pump room bottom protection arranged in accordance with the provisions of MARPOL Annex I, Chapter 3, Part A, Regulation 12A and Chapter 4, Part A, Regulation 22, respectively.
(6) Where watertightness of watertight doors has not been confirmed by a prototype test, a hydrostatic test (filling of the watertight spaces with water) is to be carried out. See SOLAS Regulation II-1/16.2 and MSC/Circ.1176.
(7) As an alternative to the hose test, other testing methods listed in [1.6.7] to [1.6.9] may be acceptable, subject to adequacy of such testing methods being verified. See SOLAS Regulation II-1/11.1. For watertight bulkheads (item 11 a)), alternatives to the hose test may be used only where the hose test is not practicable.
(8) A structural test (see [1.4.2]) is also to be carried out for a representative cargo hold in case of cargo holds intended for in-port ballasting. The filling level required for the structural test of such cargo holds is to be the maximum loading that will occur in-port, as indicated in the loading manual.
(9) Structural test may be waived where it is demonstrated to be impracticable, to the satisfaction of the Society.

Table 3 : Additional test requirements for special service ships/tanks

Item	Type of ship/tank	Structure to be tested	Type of test	Test head or pressure	Remarks
1	Liquefied gas carriers	Integral tanks	leak and structural	See Pt D, Ch 9, Sec 4	
		Hull structure supporting membrane or semi-membrane tanks			
		Independent tanks type A			
		Independent tanks type B			
		Independent tanks type C		See Pt D, Ch 9, Sec 4	
2	Edible liquid tanks	Independent tanks	leak and structural	The greater of: • top of the overflow • 0,9 m above top of tank **(1)**	
3	Chemical carriers	Integral or independent cargo tanks	leak and structural	The greater of: • 2,4 m above top of tank **(1)** • top of tank plus setting of any pressure relief valve **(1)**	An appropriate additional head is to be considered where a cargo tank is designed for the carriage of cargoes with specific gravities greater than 1,0
(1) Top of tank is deck forming the top of the tank excluding any hatchways.					

Table 4 : Application of leak test, coating, and provision of safe access for the different types of welded joints

Type of welded joints		Leak test	Coating **(1)**		Safe access **(2)**	
			Before leak test	After leak test but before structural test	Leak test	Structural test
Butt	Automatic	not required	allowed **(3)**	not applicable	not required	not required
	Manual or semi-automatic **(4)**	required	not allowed	allowed	required	not required
Fillet	Boundary including penetrations	required	not allowed	allowed	required	not required

(1) Coating refers to internal (tank/hold) coating, where applied, and external (shell/deck) painting. It does not refer to shop primer.
(2) Temporary means of access for verification of the leak test.
(3) The condition applies provided that the welds have been visually inspected with care, to the satisfaction of the Surveyor.
(4) Flux Core Arc Welding (FCAW) semi-automatic butt welds need not be tested, provided careful visual inspections show continuous and uniform weld profile shape, free from repairs, and the results of NDT show no significant defects.

Amendments to PART C

CHAPTER 1

Ch 1, Sec 2, [1.3] (Amendments July 2015)

Add the following requirement [1.3.6]:

1.3.6 Low-Speed Engines means diesel engines having a rated speed of less than 300 rpm.

Medium-Speed Engines means diesel engines having a rated speed of 300 rpm and above, but less than 1400 rpm.

High-Speed Engines means diesel engines having a rated speed of 1400 rpm and above.

Ch 1, Sec 2, [2.3.2]

Replace the first paragraph of requirement [2.3.2] by:

Ventilation of crankcase, and any arrangement which could produce a flow of external air within the crankcase, is in principle not permitted.

Ch 1, Sec 2 (Amendments July 2015)

Replace the title of Table 2,Table 3 and Table 4 by:

Table 2 : Monitoring of main propulsion cross-head (slow speed) diesel engines

Table 3 : Monitoring of main propulsion trunk-piston (medium or high speed) engines

Table 4 : Monitoring of trunk-piston diesel engines used for auxiliary services

Ch 1, Sec 3, [1.3]

Add the following requirement [1.3.14]:

1.3.14 Gas combustion unit (GCU)

A gas combustion unit (GCU) is an equipment fitted on gas carriers or gas-fuelled ships, allowing the disposal of the excess vapour from LNG tanks by thermal oxidation.

Gas combustion units are not generally pressure vessels; however when their fittings are of the same type than those of boilers the requirements for these fittings apply.

Ch 1, Sec 3, [1.6]

Add the following requirement [1.6.5]:

1.6.5 Gas combustion units

Gas combustion units are to be considered on a case by case basis, based on their actual arrangement, using the applicable requirements for boilers and pressure vessels.

The documents listed in Tab D are to be submitted.

Ch 1, Sec 3

Insert the following Article 7:

7 Design requirements for boil-off gas combustion units

7.1 Operating cases

7.1.1 Gas combustion units are to be capable of operating at least in the following conditions:

a) for gas carriers:

- normal boil-off handling in laden conditions
- reduced boil-off handling in ballast conditions
- during inerting and purging operations.

b) for gas-fuelled ships:

- boil-off handling during periods of slow steaming and/or no consumption from propulsion or other services of the ship
- during LNG bunkering, inerting and purging operations.

7.2 Availability

7.2.1 Main components of the GCU(s):

- mechanical non-static components such as fans,
- electronic cards pertaining to the control and monitoring system,

are to be duplicated so that the nominal capacity of the GCU(s) can be sustained or restored in case of single failure of such components.

7.2.2 The time necessary to restore the GCU operation in case of a component failure is to be consistent with the expected operating profile of the GCU and with the increase rate of the pressure in the tanks. In this respect, spare components ready for installation in a short time may be considered in lieu of duplicated components.

7.3 Gas combustion equipment

7.3.1 General

The gas combustion unit is to exhibit no visible flame.

7.3.2 Flue gas temperature

The flue gas temperature at the GCU outlet, after possible dilution, is not to exceed 535°C.

Note 1: The attention is drawn to certain national or international rules that may impose different temperature limits.

In case of emergency shut-down of the GCU, the flue gas temperature is not to exceed the aforementioned value. Otherwise, an emergency water cooling system is to be provided.

7.3.3 Combustion chamber

The combustion chamber is to be of suitable form such as not to present pockets where gas may accumulate.

The flame length is to remain within the gas combustion chamber in all expected operating cases, irrespective of the gas composition and gas pressure.

The combustion chamber is to be fitted with at least two flame monitoring devices, one for the alarm activation and one to shut off the gas supply in the case of flame failure.

7.3.4 Means for ignition

Each gas burner is to be fitted with at least two means for ignition, such as electrical igniters or pilot burners supplied with oil fuel.

7.4 Gas supply

7.4.1 Gas piping system

The gas piping system fitted to the GCU is to comply with the relevant provisions of IGC Code, Chapter 16 or IGF Code, Section 9, as appropriate.

7.4.2 Inerting

Provisions are to be made for inerting and gas-freeing the portion of the gas piping system located in the GCU compartment.

Note 1: Where it is demonstrated that the natural gas-freeing of the GCU burner and of its gas supply piping is efficient, the connection to the inert gas system may be omitted, subject to the flag authorities agreement.

7.5 Instrumentation and safeties

7.5.1 The GCU control system as well as the related systems are to be of a type approved by the Society.

7.5.2 The alarm and safety systems are to be provided in accordance with Tab E.

Ch 1, Sec 3

Insert the following Table D and Table E:

Table D : Documentation to be submitted for gas combustion units

Item N°	I/A **(1)**	Document **(2)**
1	A	General arrangement plan
2	I	For each intended operating case: • description, including firing and shut-off sequences, purging sequence, etc. • minimum and maximum allowed gas flow rate • maximum flue gas temperature
3	I	Material specification
4	A	Details of refractor or insulation arrangement, as applicable
5	A	Details of combustion air and dilution air systems
6	A	Diagram of the gas supply system with details of the piping (pipe material, thickness, type of the connections)
7	A	Details of electrical equipment (including safety characteristics)
8	A	Details of control, monitoring and safety systems
9	I	Procedure for workshop and shipboard tests

(1) A = to be submitted for approval
I = to be submitted for information
(2) Diagrams are also to include, where applicable, the local and remote control systems, monitoring systems and automation systems

Table E : Gas combustion units alarm and safety systems

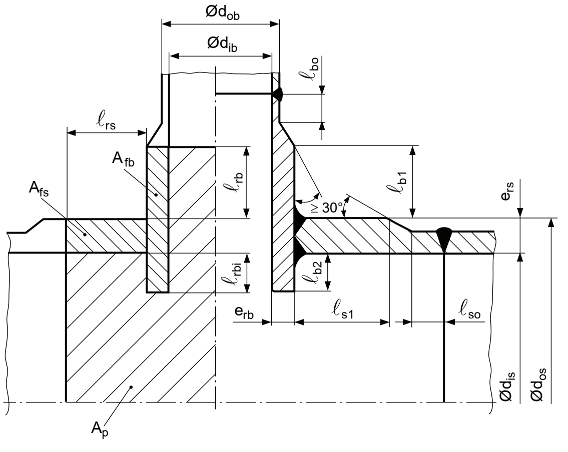
Parameter	Alarms	Automatic safety actions		
		Automatic shut down of the GCU	Activation of the master gas valve	Other automatic actions
Gas supply - pressure	L	X		
Gas supply - temperature	L+H	X		
Combustion fans, dilution fans or combined fans - failure	X			Start of the stand-by fan
Flame - loss	X	X		
Flame monitoring device - failure	X			
Flue gas at the stack outlet - temperature	H HH	 X		
GCU stop from any cause	X			Activation of the block-and-bleed valves **(1)**
Control power supply - failure	X			
Double wall gas piping system **(2)** - gas leakage	X	X	X	
Double wall gas piping system **(2)** - lost of exhaust ventilation	X	X	X	
Single wall gas piping system - gas detection in the GCU space **(3)**	X	X	X	De-energization of the non-safe electrical equipment
Single wall gas piping system - loss of ventilation in the GCU space **(3)**	X	X	X	De-energization of the non-safe electrical equipment

(1) For gas carriers and gas-fuelled ships. Refer to IGC Code, reg. 16.4.5 or IGF Code, reg. 9.4.4 as applicable
(2) For gas carriers and gas-fuelled ships. Refer to IGC Code, reg. 16.4.6.3 or IGF Code, Table 1, as applicable
(3) Only for gas-fuelled ships. Refer to IGF Code, reg. 5.6.3.3 and Table 1
Note 1: Symbol convention: H = High, HH = High high, L = Low, X = function is required

Ch 1, Sec 3 (Amendments July 2015)

Replace Figure 10 by:

Figure 10 : Reinforcement by set-through and full penetration welded branch



Ch 1, Sec 6, [2.1.1] (Amendments July 2015)

Add the definition of symbol m_t and replace the definition of symbol v as follows:

m_t : Transverse module, in mm

v : Linear velocity at pitch diameter, in m/s

Ch 1, Sec 7, Table 2 (Amendments July 2015)

Replace the first line of tablefootnote (6) by:

(6) Subject to limitations as $\ell/d_o < 0,8$ and $d_i/d_o < 0,7$ and $e/d_o > 0,15$, where:

Ch 1, Sec 9, Table 1 (Amendments July 2015)

Replace the first line of tablefootnote (3) by:

(3) Subject to limitations as $\ell/d_o < 0,8$ and $d_i/d_o < 0,7$ and $e/d_o > 0,15$, where:

Ch 1, Sec 10, [20.2.2], item a) (Amendments July 2015)

Replace item a) 2) by:

2) Tightness test during immersion/emerging in water

   An automatic closing device is to be subjected to a series of tightness tests involving not less than two immersion cycles under each of the following conditions:

   - The automatic closing device is to be submerged slightly below the water surface at a velocity of approximately 4 m/min. and then returned to the original position immediately. The quantity of leakage is to be recorded.
   - The automatic closing device is to be submerged to a point slightly below the surface of the water. The submerging velocity is to be approximately 8 m/min and the air pipe vent head is to remain submerged for not less than 5 minutes. The quantity of leakage is to be recorded.
   - Each of the above tightness tests is to be carried out in the normal position as well as at an inclination of 40°under the strictest conditions for the device. In cases where such strictest conditions are not clear, tests shall be carried out at an inclination of 40 degrees with the device opening facing in three different directions: upward, downward, sideways (left or right). See Fig 6 and Fig 7.

Add the following item a) 3):

3) Discharge / Reverse flow test

The air pipe head shall allow the passage of air to prevent excessive vacuum developing in the tank. A reverse flow test shall be performed. A vacuum pump or another suitable device shall be connected to the opening of the air pipe leading to the tank. The flow velocity shall be applied gradually at a constant rate until the float gets sucked and blocks the flow. The velocity at the point of blocking shall be recorded. 80% of the value recorded will be stated in the certificate.

The maximum allowable leakage per cycle is not to exceed 2 ml/mm of nominal diameter of inlet pipe during any individual test.

Ch 1, Sec 10 (Amendments July 2015)

Add the following Figure 6 and Figure 7:

Figure 6 : Example of normal position

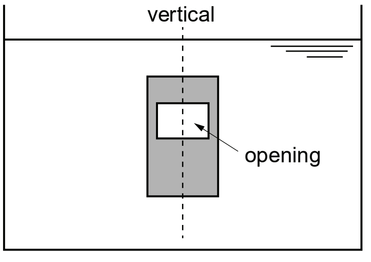
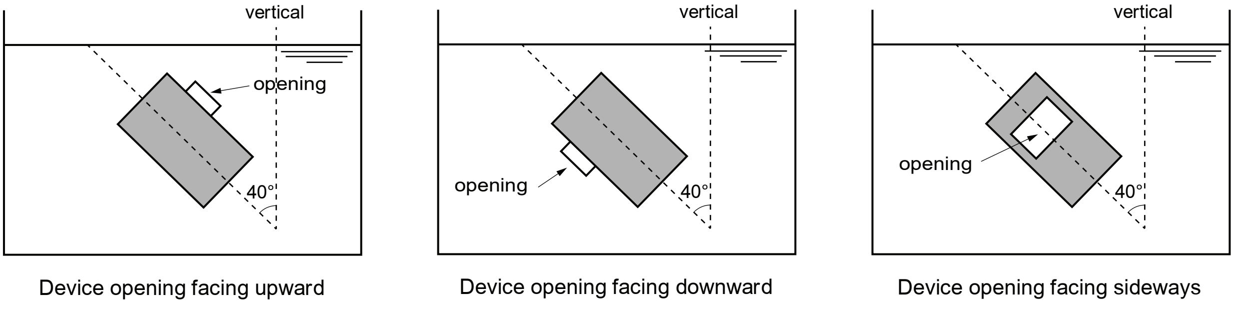


Figure 7 : Examples of inclination of 40° with different directions of the device opening



Ch 1, Sec 11, [2.2.1]

Replace item b) of the alphanumeric list in requirement [2.2.1] by:

b) *capable of putting the rudder over from 35° on one side to 35° on the other side with the ship at its deepest seagoing draught and running ahead at maximum ahead service speed and, under the same conditions, from 35° on either side to 30° on the other side in not more than 28 s*

Where it is impractical to demonstrate compliance with this requirement during sea trials with the ship at its deepest seagoing draught and running ahead at the speed corresponding to the number of maximum continuous revolutions of the main engine and maximum design pitch, ships may demonstrate compliance with this requirement by one of the following methods:

- *during sea trials the ship is at even keel and the rudder fully submerged whilst running ahead at the speed corresponding to the number of maximum continuous revolutions of the main engine and maximum design pitch; or*
- *where full rudder immersion during sea trials cannot be achieved, an appropriate ahead speed shall be calculated using the submerged rudder blade area in the proposed sea trial loading condition. The calculated ahead speed shall result in a force and torque applied to the main steering gear which is at least as great as if it was being tested with the ship at its deepest seagoing draught and running ahead at the speed corresponding to the number of maximum continuous revolutions of the main engine and maximum design pitch; or*
- *the rudder force and torque at the sea trial loading condition have been reliably predicted and extrapolated to the full load condition. The speed of the ship shall correspond to the number of maximum continuous revolutions of the main engine and maximum design pitch of the propeller;*

Ch 1, Sec 11, [2.2.2]

Replace item b) of the alphanumeric list in requirement [2.2.2] by:

b) capable of putting the rudder over from 15° on one side to 15° on the other side in not more than 60s with the ship at its deepest seagoing draught and running ahead at one half of the maximum ahead service speed or 7 knots, whichever is the greater.

Where it is impractical to demonstrate compliance with this requirement during sea trials with the ship at its deepest seagoing draught and running ahead at one half of the speed corresponding to the number of maximum continuous revolutions of the main engine and maximum design pitch or 7 knots, whichever is greater, ships may demonstrate compliance with this requirement by one of the following methods:

- *during sea trials the ship is at even keel and the rudder fully submerged whilst running ahead at one half of the speed corresponding to the number of maximum continuous revolutions of the main engine and maximum design pitch or 7 knots, whichever is greater; or*
- *where full rudder immersion during sea trials cannot be achieved, an appropriate ahead speed shall be calculated using the submerged rudder blade area in the proposed sea trial loading condition. The calculated ahead speed shall result in a force and torque applied to the auxiliary steering gear which is at least as great as if it was being tested with the ship at its deepest seagoing draught and running ahead at one half of the speed corresponding to the number of maximum continuous revolutions of the main engine and maximum design pitch or 7 knots, whichever is greater; or*
- *the rudder force and torque at the sea trial loading condition have been reliably predicted and extrapolated to the full load condition;*

and,

Ch 1, Sec 15, [3.5.2] (Amendments July 2015)

Replace Note 1 by:

Note 1: The present test is to be performed only where permitted by the engine adjustment, see Ch 1, Sec 2, [4.5.2], Note 1.

Chapter 1

Replace Appendix 1 by the following Appendix 1: (Amendments July 2015)

Replace Appendix 2 by the following Appendix 2:

APPENDIX 1 CALCULATION OF CRANKSHAFTS FOR INTERNAL COMBUSTION ENGINES

Symbols

B : Width of the web, in mm (see Fig 3)
In case of 2-stroke semi-built crankshafts, B is to be taken in way of crankpin fillet radius centre according to Fig 3

D : Crankpin diameter, in mm (see Fig 3 and Fig 4)

D_A : Outside diameter of web, in mm, as defined in [1.2.1], item p)

D_{BG} : Diameter of axial bore in journal, in mm (see Fig 3 and Fig 4)

D_{BH} : Diameter of axial bore in crankpin, in mm (see Fig 3)

D_G : Journal diameter, in mm (see Fig 3 and Fig 4)

D_O : Diameter of oil bore in crankpin, in mm (see Fig 5)

D_S : Shrink-fit diameter, in mm (see Fig 4)

E : Pin eccentricity, in mm (see Fig 3)

F : Area, in mm², related to the reference cross-section of web, equal to:
$F = B\ W$

K : Crankshaft manufacturing process factor, as defined in [6.1.1], item a)

K_e : Empirical factor considering to some extent the influence of adjacent crank and bearing restraint, and taken as follows:

- $K_e = 0{,}8$ for 2-stroke engines
- $K_e = 1{,}0$ for 4-stroke engines

L_S : Axial length of the shrink-fit, in mm (see Fig 4)

M_{BO} : Bending moment calculated at the outlet of crankpin oil bore, in N·m, equal to:
$M_{BO} = M_{BTO} \cos \psi + M_{BRO} \sin \psi$

M_{BOmax} : Maximum value of the bending moment M_{BO} within one working cycle, in N·m

M_{BOmin} : Minimum value of the bending moment M_{BO} within one working cycle, in N·m

M_{BON} : Alternating bending moment calculated at the outlet of crankpin oil bore, in N·m, defined in [2.1.2], item d)

M_{BRF} : Bending moment acting in web, in N·m, as defined in [2.1.1], item c)

M_{BRFmax} : Maximum value of the bending moment M_{BRF} within one working cycle, in N·m

M_{BRFmin} : Minimum value of the bending moment M_{BRF} within one working cycle, in N·m

M_{BRFN} : Alternating bending moment related to the centre of the web, in N·m, defined in [2.1.2], item b)

M_{BRO} : Bending moment of the radial component of the connecting rod force, in N·m (see Fig 5)

M_{BTO} : Bending moment of the tangential component of the connecting rod force, in N·m (see Fig 5)

M_T : Torque, in N·m

M_{Tmax} : Maximum value of the torque M_T within one working cycle, in N·m

M_{Tmin} : Minimum value of the torque M_T within one working cycle, in N·m

M_{TN} : Alternating torque, in N·m, as defined in [2.2.2]

Q_1 : Acceptability factor for the crankpin fillet, as defined in [7.1.1]

Q_2 : Acceptability factor for the journal fillet, as defined in [7.1.1]

Q_3 : Acceptability factor for the crankpin outlet of oil bore, as defined in [7.1.1]

Q_{RF} : Radial force acting in web, in N, as defined in [2.1.1], item c)

Q_{RFmax} : Maximum value of the radial force Q_{RF} within one working cycle, in N

Q_{RFmin} : Minimum value of the radial force Q_{RF} within one working cycle, in N

Q_{RFN} : Alternating radial force related to the web, in N, as defined in [2.1.2], item c)

R_G : Fillet radius of journal, in mm (see Fig 3 and Fig 4)

R_H : Fillet radius of crankpin, in mm (see Fig 3)

R_m : Minimum specified tensile strength of crankshaft material, in N/mm²

S : Pin overlap, in mm, given by the following formula (see Fig 3):

$$S = \frac{D + D_G}{2} - E$$

Where pins do not overlap, the negative value of S calculated by the above formula is to be considered

T_G : Recess of journal fillet, in mm (see Fig 3)

T_H : Recess of crankpin fillet, in mm (see Fig 3)

W : Axial web thickness, in mm (see Fig 3)

W_e : Section modulus related to the cross-section of axially bored crankpin, in mm^3, equal to:

$$W_e = \frac{\pi}{32}\left(\frac{D^4 - D_{BH}^4}{D}\right)$$

W_{eqw} : Section modulus related to the cross-section of web, in mm^3, equal to:

$$W_{eqw} = \frac{B \cdot W^2}{6}$$

W_{PG} : Polar section modulus related to cross-section of axially bored journal, in mm^3, equal to:

$$W_{PG} = \frac{\pi}{16}\left(\frac{D_G^4 - D_{BG}^4}{D_G}\right)$$

W_{PH} : Polar section modulus related to cross-section of axially bored crankpin, in mm^3, equal to:

$$W_{PH} = \frac{\pi}{16}\left(\frac{D^4 - D_{BH}^4}{D}\right)$$

W_{red} : Reduced axial web thickness, in mm, to be considered instead of W in the case of 2-stroke semi-built crankshafts with $T_H > R_H$ and to be taken as equal to (see Fig 3):

$W_{red} = W - (T_H - R_H)$

α_B : Stress concentration factor for bending in crankpin fillet, as evaluated in [3.1.2], item a)

α_T : Stress concentration factor for torsion in crankpin fillet, as evaluated in [3.1.2], item b)

β_B : Stress concentration factor for bending in journal fillet, as evaluated in [3.1.3], item a)

β_Q : Stress concentration factor for compression due to radial force in journal fillet, as evaluated in [3.1.3], item b)

β_T : Stress concentration factor for torsion in journal fillet, as evaluated in [3.1.3], item c)

γ_B : Stress concentration factor for bending in crankpin oil bore, as evaluated in [3.1.4]

γ_T : Stress concentration factor for torsion in outlet of crankpin oil bore, as evaluated in [3.1.4]

σ_{add} : Additional bending stress, in N/mm^2, due to misalignment, as defined in [4.1.1]

σ_{BFN} : Nominal alternating bending stress related to the web, in N/mm^2, as defined in [2.1.2], item b)

σ_{BG} : Alternating bending stress in journal fillet, in N/mm^2, as defined in [2.1.3], item b)

σ_{BH} : Alternating bending stress in crankpin fillet, in N/mm^2, as defined in [2.1.3], item a)

σ_{BO} : Alternating bending stress in outlet of crankpin oil bore, in N/mm^2, as defined in [2.1.4]

σ_{BON} : Nominal alternating bending stress related to the crankpin diameter, in N/mm^2, as defined in [2.1.2], item d)

σ'_{DW} : Allowable alternating bending fatigue strength of crankshaft in the crankpin fillet area, in N/mm^2, as defined in [6.1.1], item a)

σ''_{DW} : Allowable alternating bending fatigue strength of crankshaft in the journal fillet area, in N/mm^2, as defined in [6.1.1], item b)

σ'''_{DW} : Allowable alternating bending fatigue strength of crankshaft in the crankpin oil bore area, in N/mm^2, as defined in [6.1.1], item c)

σ_{QFN} : Nominal alternating compressive stress due to radial force related to the web, in N/mm^2, as defined in [2.1.2], item c)

σ_{TO} : Alternating torsional stress in outlet of crankpin oil bore, in N/mm^2, as defined in [2.2.3], item c)

σ'_V : Equivalent alternating stress in way of crankpin fillet, in N/mm^2, as defined in [5.2.1], item a)

σ''_V : Equivalent alternating stress in way of journal fillet, in N/mm^2, as defined in [5.2.1], item b)

σ'''_V : Equivalent alternating stress in way of outlet of crankpin oil bore, in N/mm^2, as defined in [5.2.1], item c)

τ_G : Alternating torsional stress in journal fillet, in N/mm^2, as defined in [2.2.3], item b)

τ_H : Alternating torsional stress in way of crankpin fillet, in N/mm^2, as defined in [2.2.3], item a)

τ_{NG} : Nominal alternating torsional stress related to journal diameter, in N/mm^2, as defined in [2.2.2]

τ_{NH} : Nominal alternating torsional stress related to crankpin diameter, in N/mm^2, as defined in [2.2.2]

ψ : Angular position, in deg (see Fig 5).

1 General

1.1 Application

1.1.1

a) These Rules for the design of crankshafts are to be applied to I.C. engines for propulsion and auxiliary purposes, where the engines are capable of continuous operation at their rated power when running at rated speed.

Where a crankshaft design involves the use of surface treated fillets, or when fatigue parameter influences are tested, or when working stresses are measured, the relevant documents with calculations/analysis are to be submitted to the Society in order to demonstrate equivalence to the Rules.

b) These Rules apply only to solid-forged and semi-built crankshafts of forged or cast steel, with one crank throw between main bearings.

1.2 Documentation to be submitted

1.2.1 The following documents and particulars required for the calculation of crankshafts as indicated in Ch 1, Sec 2, Tab 1, item 1 are to be submitted:

a) engine builder

b) crankshaft drawings containing all the data in respect of the geometrical configurations of the crankshaft

c) engine type designation

d) kind of engine:
   - in-line engine or V-type engine with adjacent connecting rods
   - V-type engine with forked/inner connecting rods
   - V -type engine with articulated-type connecting rods
   - crosshead engine or trunk piston engine

e) operating method: 2-stroke or 4-stroke cycle

f) combustion method: direct injection, precombustion chamber, etc

g) number of cylinders

   diameter of cylinders, in mm

   length of piston stroke, in mm

   length of connecting rod (between bearing centers), in mm

h) rated power, in kW

   rated engine speed, in rpm

   mean effective pressure, in bar

   mean indicated pressure, in bar

   maximum net cylinder pressure Pmax, in bar

   charge air pressure (before inlet valves or scavenge ports, whichever applies), in bar

   nominal compression ratio

i) direction of rotation: clockwise or counter clockwise (see Fig 1)

j) firing order (corresponding to item i) with the respective ignition intervals, in deg

k) oscillating mass of one cylinder (mass of piston, rings, pin, piston rod, crosshead, oscillating part of connecting rod), in kg

   mass of connecting rod, in kg, and position of gravity centre

l) digitalized gas pressure curve presented at equidistant intervals, in bar versus crank angle (at least every 5° CA)

m) for V-type engines: V-angle α_v , in deg (see Fig 1)

n) data of crankshaft:
   - drawing number
   - kind of crankshaft (e.g. solid-forged crankshaft, semi-built crankshaft, etc.)
   - method of manufacture (e.g. free form forged, continuous grain flow forged, drop-forged, etc.), with description of the forging process
   - heat treatment (e.g. tempered)
   - every surface treatment affecting fillets or oil holes
   - particulars of alternating torsional stress calculations (see [2.2])

o) crank dimensions necessary for the calculation of stress concentration factors, in mm unless other specified (see Fig 2 and Fig 3):
   - crankpin diameter D
   - diameter of axial bore in crankpin D_{BH}
   - fillet radius of crankpin R_H
   - recess of crankpin fillet T_H
   - journal diameter D_G
   - diameter of axial bore in journal D_{BG}
   - fillet radius of journal R_G
   - recess of journal fillet T_G
   - web thickness W
   - web width B
   - bending length L_1
   - bending length L_2
   - bending length L_3
   - diameter of oil bore in crankpin D_O
   - smallest edge radius of oil bore
   - surface roughness of oil bore fillet
   - inclination of oil bore axis related to shaft axis Y, in deg

Figure 1 : Designation of the cylinders

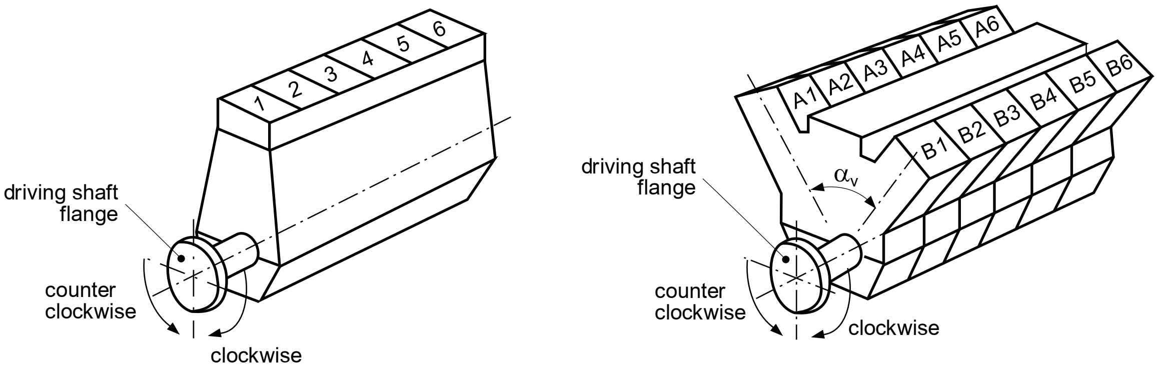
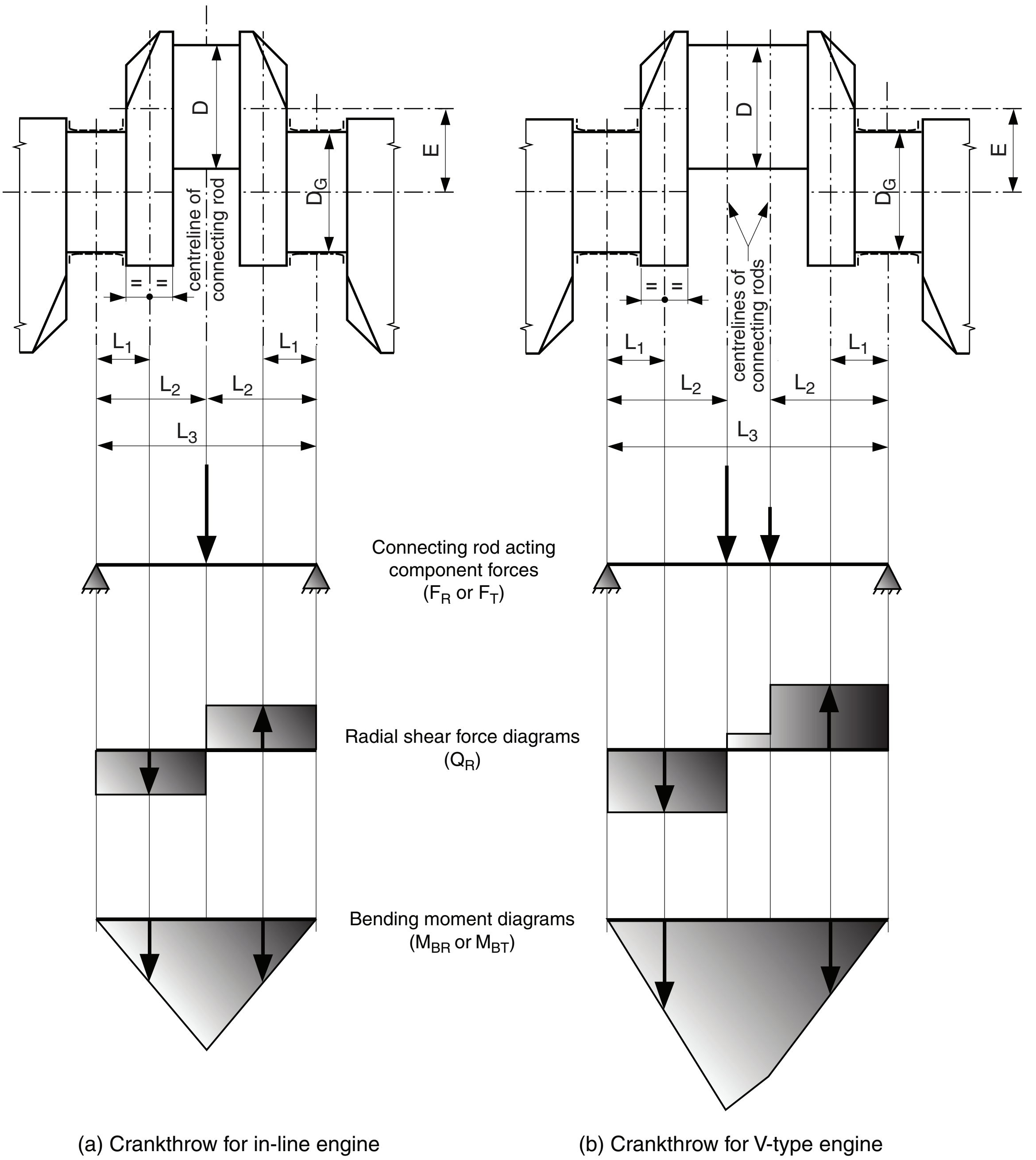


Figure 2 : Crank throw of solid crankshaft

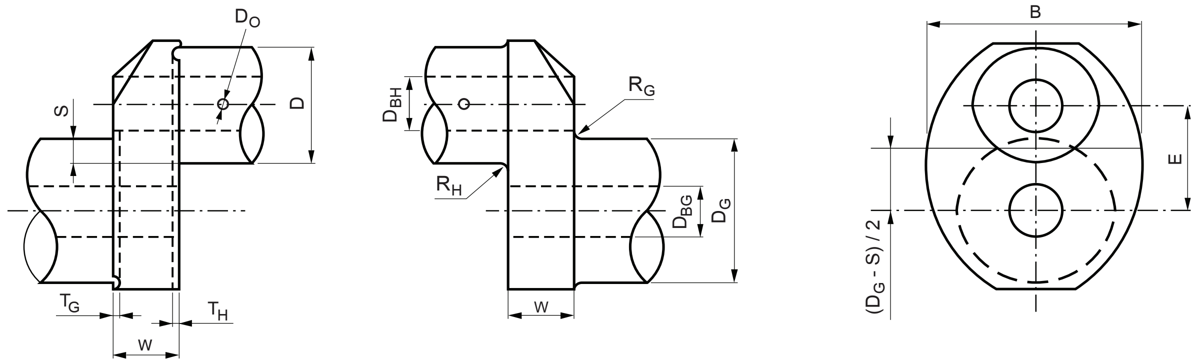


(a) Crankthrow for in-line engine (with one connecting rod)

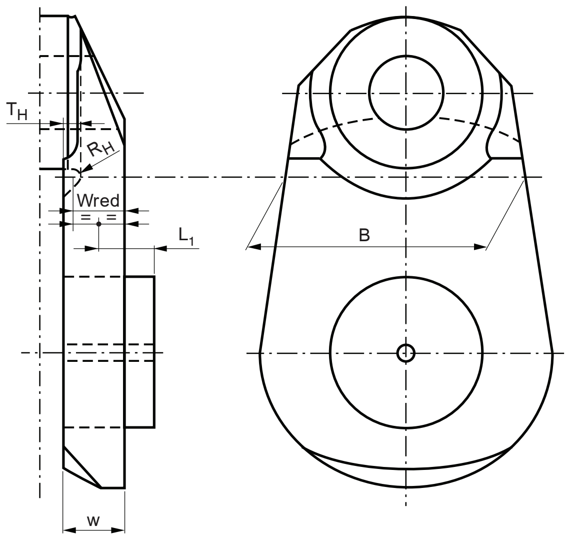
(b) Crankthrow for V-type engine (with two adjacent connecting rods)

L_1	:	Distance between main journal centreline and crankweb centre (see also Fig 3 for crankshaft without overlap)
L_2	:	Distance between main journal centreline and connecting rod centre
L_3	:	Distance between two adjacent main journal centrelines

Figure 3 : Reference area of crankweb cross-section and crank dimensions

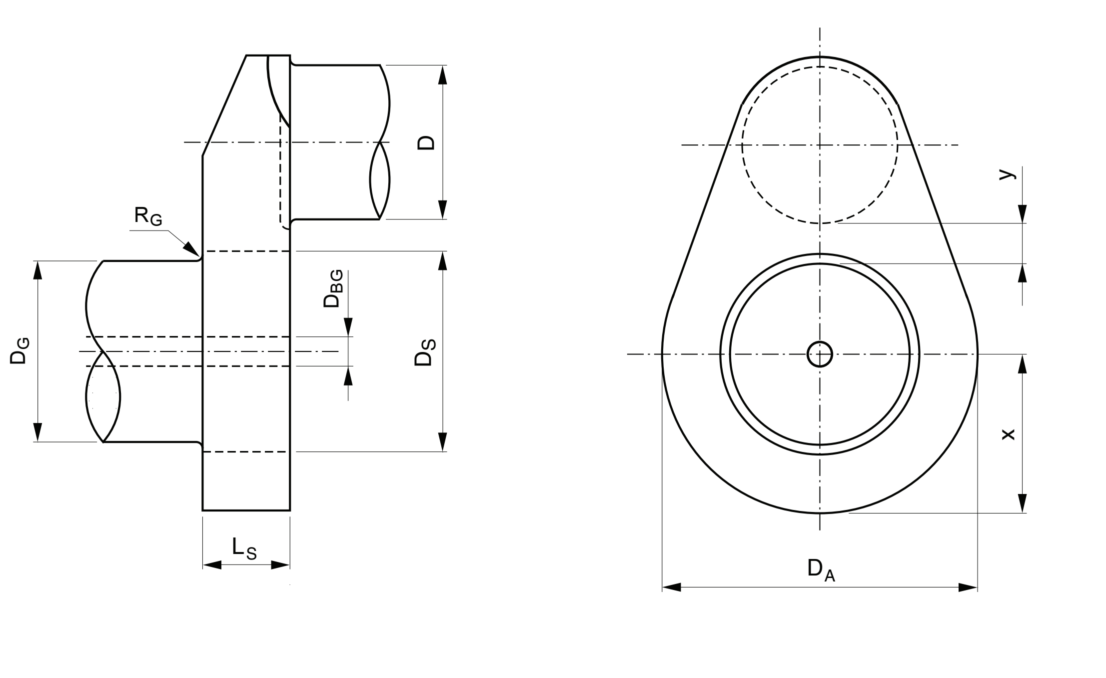


Overlapped crankshaft



Crankshaft without overlap

Figure 4 : Crank throw of semi-built crankshaft



p) additional data for shrink-fits of semi-built crankshafts, in mm unless other specified (see Fig 4):
   - shrink diameter D_S
   - length of shrink-fit L_S
   - outside diameter of web D_A or twice the minimum distance x (see Fig 4) between centreline of journals and outer contour of web, whichever is less
   - distance y between the adjacent generating lines of journal and pin connected to the same web

     In general: $y \geq 0,05\ D_S$

     Where y is less than 0,1 D_S , special consideration is to be given by the Society to the effect of the stress due to the shrink-fit on the fatigue strength at the crankpin fillet
   - amount of shrink-fit (upper and lower tolerances)
   - maximum torque, in N·m
   - maximum nominal alternating torsional stress (ascertained by means of a harmonic synthesis and related to cross-sectional area of bored crankpin), in N/mm²
   - engine speed (at which the maximum nominal alternating torsional stress occurs), in rpm
   - minimum engine speed (for which the harmonic synthesis was carried out), in rpm

q) details of crankshaft material:
   - material designation (according to ISO, EN, DIN, AISI, etc.)
   - mechanical properties of material (minimum values obtained from longitudinal test specimens):
     - tensile strength, in N/mm²
     - yield strength, in N/mm²
     - reduction in area at break, in %
     - elongation A_5 , in %
     - impact energy – KV, in J
     - Young's modulus, in N/mm²
   - method of crankshaft material melting process (e.g. open-hearth furnace, electric furnace, etc.)

r) data of stress concentration factors (S.C.F.) to be given only when data for stress concentration factors and/or fatigue are furnished by the engine manufacturer on the basis of measurements (full supporting details are to be enclosed):
   - S.C.F. for bending in crankpin fillet α_B
   - S.C.F. for torsion in crankpin fillet α_T
   - S.C.F. for bending in journal fillet β_B
   - S.C.F. for torsion in journal fillet β_T
   - S.C.F. for compression in journal fillet β_Q

   allowable fatigue strength of crankshaft σ_{DW} , in N/mm².

1.3 Principles of calculation

1.3.1 The design of crankshafts is based on an evaluation of safety against fatigue in the highly stressed areas.

The calculation is also based on the assumption that the areas exposed to highest stresses are:

- fillet transitions between the crankpin and web as well as between the journal and web
- outlets of crankpin oil bores.

When the journal diameter is equal to or larger than the crankpin one, the outlets of main journal oil bores are to be formed in a similar way to the crankpin oil bores, otherwise separate documentation of fatigue safety may be required.

Calculation of crankshaft strength consists initially in determining the nominal alternating bending (see [2.1]) and nominal alternating torsional stresses (see [2.2]) which, multiplied by the appropriate stress concentration factors using the theory of constant energy of distortion (von Mises' Criterion, see [3]), result in an equivalent alternating stress (uni-axial stress, see [5]). This equivalent alternating stress is then compared with the fatigue strength of the selected crankshaft material (see [6]). This comparison will show whether or not the crankshaft concerned is dimensioned adequately (see [7]).

2 Calculation of alternating stresses

2.1 Calculation of alternating stresses due to bending moments and radial forces

2.1.1 Assumptions

a) The calculation is based on a statically determined system, composed of a single crank throw supported in the centre of adjacent main journals and subject to gas and inertia forces. The bending length is taken as the length between the two main bearing midpoints (distance L_3, see Fig 2 (a) and Fig 2 (b)).

b) The bending moments M_{BR} and M_{BT} are calculated in the relevant section based on triangular bending moment diagrams due to the radial component F_R and the tangential component F_T of the connecting rod force, respectively (see Fig 2 (a)).

   For crank throws with two connecting rods acting upon one crankpin, the relevant bending moments are obtained by superposition of the two triangular bending moment diagrams according to phase (see Fig 2 (b)).

c) Bending moments and radial forces acting in web

   The bending moment M_{BRF} and the radial force Q_{RF} are taken as acting in the centre of the solid web (distance L_1 in Fig 2) and are derived from the radial component of the connecting rod force.

   The alternating bending and compressive stresses due to bending moments and radial forces are to be related to the cross-section of the crank web:
   - at the centre of the overlap S in cases of overlap of the pins (see Fig 3), and
   - at the centre of the distance y between the adjacent generating lines of the two pins in cases of pins which do not overlap (see Fig 4).

   This reference cross-section results from the web thickness W and the web width B (see Fig 3).

   Mean stresses are neglected.

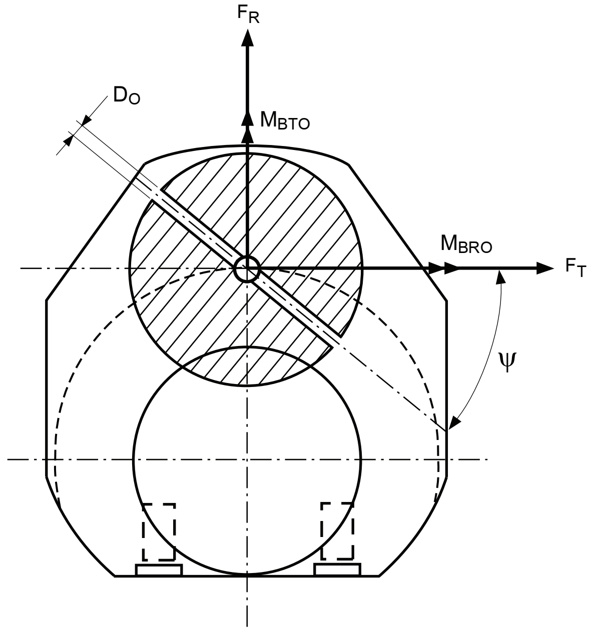
d) Bending acting in outlet of crankpin oil bore

The two relevant bending moments M_{BRO} and M_{BTO} (see Symbols and Fig 5) are taken in the crankpin cross-section through the oil bore.

The alternating stresses due to these bending moments are to be related to the cross-sectional area of the axially bored crankpin.

Mean bending stresses are neglected.

Figure 5 : Crankpin section through the oil bore



2.1.2 Calculation of nominal alternating bending and compressive stresses in web

a) The radial and tangential forces due to gas and inertia loads acting upon the crankpin at each connecting rod position will be calculated over one working cycle.

A simplified calculation of the radial forces may be used at the discretion of the Society.

Using the forces calculated over one working cycle and taking into account of the distance from the main bearing midpoint, the time curve of the bending moments M_{BRF} , M_{BRO} , M_{BTO} and radial forces Q_{RF} (see Symbols) will be then calculated.

In case of V-type engines, the bending moments (progressively calculated from the gas and inertia forces and for the various crank angles) of the two cylinders acting on one crank throw are superposed according to phase. Different designs (forked connecting rod, articulated-type connecting rod or adjacent connecting rods) shall be taken into account.

Where there are cranks of different geometrical configurations (e.g. asymmetrical cranks) in one crankshaft, the calculation is to cover all crank variants.

b) Nominal alternating bending stress in web cross-section

The nominal alternating bending stress σ_{BFN} related to the web is calculated, in N/mm², as follows:

$$\sigma_{BFN} = \pm \frac{M_{BRFN}}{W_{eqw}} \cdot K_e \cdot 10^3$$

where:

M_{BRFN} : Alternating bending moment related to the centre of the web, in N·m, equal to (see Fig 2 (a) and Fig 2 (b)):

$$M_{BRFN} = \pm 0{,}5\ (M_{BRFmax} - M_{BRFmin})$$

W_{eqw} , K_e , M_{BRFmax} , M_{BRFmin} : As defined in Symbols.

c) Nominal alternating compressive stress in web cross-section

The nominal alternating compressive stress σ_{QFN} due to radial force related to the web is calculated, in N/mm², as follows:

$$\sigma_{QFN} = \pm \frac{Q_{RFN}}{F} \cdot K_e$$

where:

Q_{RFN} : Alternating radial force related to the web, in N, equal to (see Fig 2 (a) and Fig 2 (b)):

$$Q_{RFN} = \pm 0{,}5\ (Q_{RFmax} - Q_{RFmin})$$

F, K_e , Q_{RFmax} , Q_{RFmin} : As defined in Symbols.

d) Nominal alternating bending stress in outlet of crankpin oil bore

The nominal alternating bending stress σ_{BON} related to the crankpin diameter is calculated, in N/mm², as follows:

$$\sigma_{BON} = \pm \frac{M_{BON}}{W_e} \cdot 10^3$$

where:

M_{BON} : Alternating bending moment calculated at the outlet of crankpin oil bore, in N·m, equal to:

$$M_{BON} = \pm 0{,}5\ (M_{BOmax} - M_{BOmin})$$

W_e , M_{BOmax} , M_{BOmin} : As defined in Symbols.

2.1.3 Calculation of alternating bending stresses in fillets

a) The alternating bending stress σ_{BH} in crankpin fillet is calculated, in N/mm², as follows:

$$\sigma_{BH} = \pm (\alpha_B \cdot \sigma_{BFN})$$

b) The alternating bending stress σ_{BG} in journal fillet is calculated, in N/mm², as follows (not applicable to semi-built crankshafts):

$$\sigma_{BG} = \pm (\beta_B \cdot \sigma_{BFN} + \beta_Q \cdot \sigma_{QFN})$$

where:

α_B , β_B , β_Q : Stress concentration factors as defined in [3.1]

σ_{BFN} , σ_{QFN} : Stresses as defined in [2.1.2], item b) and item c) respectively.

2.1.4 Calculation of alternating bending stress in outlet of crankpin oil bore

The alternating bending stress σ_{BO} in outlet of crankpin oil bore is calculated, in N/mm², as follows:

$$\sigma_{BO} = \pm (\gamma_B \cdot \sigma_{BON})$$

where:

γ_B : Stress concentration factor as defined in [3.1.4]

σ_{BON} : Stress as defined in [2.1.2], item d).

2.2 Calculation of alternating torsional stresses

2.2.1 General

The calculation for nominal alternating torsional stresses is to be undertaken by the engine manufacturer according to the information contained in [2.2.2].

The maximum nominal alternating torsional stress is to be specified by the manufacturer.

The maximum value obtained from such calculations will be used by the Society when determining the equivalent alternating stress according to the provisions of Article [5].

In the absence of such a maximum value, the Society reserves the right to incorporate a fixed value in the calculation for the crankshaft dimensions, to be established at its discretion in each case.

In the event of the Society being entrusted to carry out a forced vibration calculation on behalf of the engine manufacturer to determine the torsional vibration stresses expected in the engine and where relevant in the shafting, the following data are to be submitted in addition to those required in [1.2.1]:

a) equivalent dynamic system of the engine, comprising:
   - mass moment of inertia of every mass point, in $kg.m^2$
   - inertialess torsional stiffnesses, in N·m/rad, of all crankshaft parts between two mass points

b) vibration dampers, specifying:
   - type designation
   - mass moments of inertia, in $kg.m^2$
   - inertialess torsional stiffnesses, in N·m/rad
   - values of the damping coefficients, in N·m.s

c) flywheels, specifying:
   - mass moment of inertia, in $kg{\cdot}m^2$.

Where the whole propulsion system is to be considered, the following information is also to be submitted:

a) elastic couplings, specifying:
   - dynamic characteristics and damping data, as well as the permissible value of alternating torque

b) gearing and shafting, specifying:
   - shaft diameters of gear shafts, thrust shafts, intermediate shafts and propeller shafts, mass moments of inertia, in $kg{\cdot}m^2$, of gearing or important mass points, gear ratios and, for gearboxes of complex type, the schematic gearing arrangement

c) propellers, specifying:
   - propeller diameter
   - number of blades
   - pitch and developed area ratio
   - mass moment of inertia of propeller in air and with entrained water, in $kg{\cdot}m^2$ (for controllable pitch propellers both the values at full pitch and at zero pitch are to be specified)
   - damping characteristics, if available and documented

d) natural frequencies with their relevant modes of vibration and the vector sums for the harmonics of the engine excitation

e) estimated torsional vibration stresses in all important elements of the system with particular reference to clearly defined resonance speeds of rotation and continuous operating ranges.

2.2.2 Calculation of nominal alternating torsional stresses

The maximum and minimum values of the alternating torques are to be ascertained for every mass point of the complete dynamic system and for the entire speed range by means of a harmonic synthesis of the forced vibrations from the 1st order up to and including the 15^{th} order for 2-stroke cycle engines and from the $0,5^{th}$ order up to and including the 12^{th} order for 4-stroke cycle engines.

In performing this calculation, allowance is to be made for the damping that exists in the system and for unfavourable conditions (e.g., misfiring in one of the cylinders).

Note 1: Misfiring is defined as cylinder condition when no combustion occurs but only compression cycle.

The speed step calculation shall be selected in such a way that any resonance found in the operational speed range of the engine shall be detected.

Where barred speed ranges are necessary, they shall be arranged so that satisfactory operation is possible despite their existence. There are to be no barred speed ranges above a speed ratio of $\lambda \geq 0,8$ for normal firing conditions.

The values received from such calculation are to be submitted to the Society for consideration.

The nominal alternating torsional stresses referred to crankpin (τ_{NH}) and journal (τ_{NG}) in every mass point which is essential to the assessment result, in N/mm^2, from the following formulae:

$$\tau_{NH} = \pm \frac{M_{TN}}{W_{PH}} \cdot 10^3$$

$$\tau_{NG} = \pm \frac{M_{TN}}{W_{PG}} \cdot 10^3$$

where:

M_{TN} : Maximum alternating torque, in N·m, equal to:

$$M_{TN} = \pm 0,5\ (M_{Tmax} - M_{Tmin})$$

W_{PH} , W_{PG} , M_{Tmax} , M_{Tmin} : As defined in Symbols.

Bored crankpins and journals whose bore longitudinal axis does not coincide with the axis of the said crankpins and journals, will be considered by the Society in each case.

For the purpose of the crankshaft assessment, the nominal alternating torsional stress considered in further calculations is the highest calculated value, according to above method, occurring at the most torsionally loaded mass point of the crankshaft system.

Where barred speed ranges exist, the torsional stresses within these ranges are not to be considered for assessment calculations.

The approval of crankshaft will be based on the installation having the largest nominal alternating torsional stress (but not exceeding the maximum figure specified by the engine manufacturer).

Thus, for each installation, it is to be ensured by suitable calculation that this approved nominal alternating torsional stress is not exceeded. This calculation is to be submitted to the Society for assessment (see Ch 1, Sec 9).

2.2.3 Calculation of alternating torsional stresses in fillets and outlet of crankpin oil bore

The calculation of the alternating torsional stresses is to be carried out for the crankpin fillet, the journal fillet and the outlet of the crankpin oil bore, as follows:

a) the alternating torsional stress τ_H, in N/mm², in way of crankpin fillet is given by the following formula:

$$\tau_H = \pm (\alpha_T \cdot \tau_{NH})$$

b) the alternating torsional stress τ_G, in N/mm², in way of journal fillet is given by the following formula (not applicable to semi-built crankshafts):

$$\tau_G = \pm (\beta_T \cdot \tau_{NG})$$

c) the alternating torsional stress σ_{TO}, in N/mm², in way of outlet of crankpin oil bore is given by the following formula:

$$\sigma_{TO} = \pm (\gamma_T \cdot \tau_{NH})$$

where:

α_T, β_T, γ_T, τ_{NG}, τ_{NH} : As defined in Symbols.

3 Stress concentration factors (SCF)

3.1 Evaluation of stress concentration factors

3.1.1 General

The stress concentration factors are evaluated by means of the formulae according to [3.1.2], [3.1.3] and [3.1.4] applicable to the fillets and crankpin oil bore of solid forged web-type crankshafts and to the crankpin fillets of semi-built crankshafts only. It is to be noticed that stress concentration factor formulae concerning the oil bore are only applicable to a radially drilled oil hole. All formulae are based on investigations of FVV (Forschungsvereinigung Verbrennungskraftmaschinen) for fillets and on investigations of ESDU (Engineering Science Data Unit) for oil holes.

Where the geometry of the crankshaft is outside the boundaries of the analytical stress concentration factors, the calculation method detailed in Article [9] may be undertaken.

All crank dimensions necessary for the calculation of stress concentration factors are shown in Fig 3.

The stress concentration factors for bending (α_B and β_B) are defined as the ratio of the maximum equivalent von Mises stress (occurring in the fillets under bending load) to the nominal bending stress related to the web cross-section.

The stress concentration factor for compression (β_Q) in the journal fillet is defined as the ratio of the maximum equivalent von Mises stress (occurring in the fillet due to the radial force) to the nominal compressive stress related to the web cross-section.

The stress concentration factors for torsion (α_T and β_T) are defined as the ratio of the maximum equivalent shear stress (occurring in the fillets under torsional load) to the nominal torsional stress related to the axially bored crankpin or journal cross-section.

The stress concentration factors for bending (γ_B) and torsion (γ_T) are defined as the ratio of the maximum principal stress (occurring at the outlet of the crankpin oil hole under bending and torsional loads) to the corresponding nominal stress related to the axially bored crankpin cross-section.

When reliable measurements and/or calculations are available, which can allow direct assessment of stress concentration factors, the relevant documents and their analysis method have to be submitted to the Society in order to demonstrate their equivalence to the present rule evaluation.

For the calculation of stress concentration factors in crankpin and journal fillets, the related dimensions given in Tab 1 are to be applied.

Table 1 : Related dimensions for calculation of stress concentration factors

Crankpin fillet	Journal fillet
$r_H = R_H / D$	$r_G = R_G / D$
$s = S / D$	
$w = W / D$ for crankshafts with overlap $w = W_{red} / D$ for crankshafts without overlap	
$b = B / D$	
$d_o = D_O / D$	
$d_H = d_{BH} / D$	$d_G = D_{BG} / D$
$t_H = T_H / D$	$t_G = T_G / D$

Stress concentration factors are valid for the following ranges of related dimensions for which the investigations have been carried out:

$0,03 \leq r_H \leq 0,13$

$0,03 \leq r_G \leq 0,13$

$s \leq 0,50$

$0,20 \leq w \leq 0,80$

$1,10 \leq b \leq 2,20$

$0 \leq d_o \leq 0,20$

$0 \leq d_H \leq 0,80$

$0 \leq d_G \leq 0,80$

Low range of s can be extended down to large negative values provided that:

- if the value of calculated factor f(recess) is less than 1, then f(recess) = 1 is to be considered
- if $s < -0,5$ then f(s,w) and f(r,s) are to be evaluated replacing the actual value of s by $s = -0,5$.

3.1.2 Crankpin fillet

a) The stress concentration factor for bending α_B is equal to:

$\alpha_B = 2{,}6914 \cdot f(s,w) \cdot f_1(w) \cdot f_1(b) \cdot f(r_H) \cdot f(d_G) \cdot f(d_H) \cdot f(recess)$

where:

$f(s,w) = -4{,}1883 + 29{,}2004\ w - 77{,}5925\ w^2 + 91{,}9454\ w^3 - 40{,}0416\ w^4 + (1 - s)\ (9{,}5440 - 58{,}3480\ w + 159{,}3415\ w^2 - 192{,}5846\ w^3 + 85{,}2916\ w^4) + (1 - s)^2\ (-3{,}8399 + 25{,}0444\ w - 70{,}5571\ w^2 + 87{,}0328\ w^3 - 39{,}1832\ w^4)$

$f_1(w) = 2{,}1790\ w^{0{,}7171}$

$f_1(b) = 0{,}6840 - 0{,}0077\ b + 0{,}1473\ b^2$

$f(r_H) = 0{,}2081\ r_H^{-0{,}5231}$

$f(d_G) = 0{,}9993 + 0{,}27\ d_G - 1{,}0211\ d_G^2 + 0{,}5306\ d_G^3$

$f(d_H) = 0{,}9978 + 0{,}3145\ d_H - 1{,}5241\ d_H^2 + 2{,}4147\ d_H^3$

$f(recess) = 1 + (t_H + t_G)\ (1{,}8 + 3{,}2\ s)$

b) The stress concentration factor for torsion α_T is equal to:

$\alpha_T = 0{,}8 \cdot f(r_H,s) \cdot f_2(b) \cdot f_2(w)$

where:

$f(r_H,s) = r_H^x$ with $x = -0{,}322 + 0{,}1015\ (1 - s)$

$f_2(b) = 7{,}8955 - 10{,}654\ b + 5{,}3482\ b^2 - 0{,}857\ b^3$

$f_2(w) = w^{-0{,}145}$

3.1.3 Journal fillet (not applicable to semi-built crankshaft)

a) The stress concentration factor for bending β_B is equal to:

$\beta_B = 2{,}7146 \cdot f_B(s,w) \cdot f_B(w) \cdot f_B(b) \cdot f_B(r_G) \cdot f_B(d_G) \cdot f_B(d_H) \cdot f(recess)$

where:

$f_B(s,w) = -1{,}7625 + 2{,}9821\ w - 1{,}5276\ w^2 + (1 - s)\ (5{,}1169 - 5{,}8089\ w + 3{,}1391\ w^2) + (1 - s)^2\ (-2{,}1567 + 2{,}3297\ w - 1{,}2952\ w^2)$

$f_B(w) = 2{,}2422\ w^{0{,}7548}$

$f_B(b) = 0{,}5616 + 0{,}1197\ b + 0{,}1176\ b^2$

$f_B(r_G) = 0{,}1908\ r_G^{-0{,}5568}$

$f_B(d_G) = 1{,}0012 - 0{,}6441\ d_G + 1{,}2265\ d_G^2$

$f_B(d_H) = 1{,}0022 - 0{,}1903\ d_H + 0{,}0073\ d_H^2$

f(recess) : As defined in [3.1.2], item a).

b) The stress concentration factor for compression β_Q due to the radial force is equal to:

$\beta_Q = 3{,}0128 \cdot f_Q(s) \cdot f_Q(w) \cdot f_Q(b) \cdot f_Q(r_G) \cdot f_Q(d_H) \cdot f(recess)$

where:

$f_Q(s) = 0{,}4368 + 2{,}1630\ (1 - s) - 1{,}5212\ (1 - s)^2$

$$f_Q(w) = \frac{w}{0{,}0637 + 0{,}9369w}$$

$f_Q(b) = -0{,}5 + b$

$f_Q(r_G) = 0{,}5331\ r_G^{-0{,}2038}$

$f_Q(d_H) = 0{,}9937 - 1{,}1949\ d_H + 1{,}7373\ d_H^2$

f(recess) : As defined in [3.1.2], item a).

c) The stress concentration factor for torsion β_T is equal to:

- if $D = D_G$ and $R_H = R_G$:

  $\beta_T = \alpha_T$

- if $D \neq D_G$ and/or $R_H \neq R_G$:

  $\beta_T = 0{,}8 \cdot f(r_H,s) \cdot f_2(b) \cdot f_2(w)$

  with $f(r_H,s)$, $f_2(b)$ and $f_2(w)$ determined in accordance with [3.1.2], item b), but taking $r_H = R_G / D_G$ instead of $r_H = R_H / D$ for the calculation of $f(r_H,s)$.

3.1.4 Outlet of crankpin oil bore

The stress concentration factors for bending γ_B and for torsion γ_T are equal to:

$\gamma_B = 3 - 5{,}88\ d_o + 34{,}6\ d_o^2$

$\gamma_T = 4 - 6\ d_o + 30\ d_o^2$

4 Additional bending stresses

4.1

4.1.1 In addition to the alternating bending stresses in fillets (see [2.1.3]), further bending stresses due to misalignment and bedplate deformation as well as due to axial and bending vibrations are to be considered, applying σ_{add} as given in Tab 2.

Table 2 : Additional bending stress σ_{add}

Type of engine	σ_{add}, in N/mm²
Crosshead engine	± 30 **(1)**
Trunk piston engine	± 10

(1) The additional stress of ± 30 N/mm² is composed of two components:
- an additional stress of ± 20 N/mm² resulting from axial vibration
- an additional stress of ± 10 N/mm² resulting from misalignment/bedplate deformation.

It is recommended that a value of ± 20 N/mm² be used for the axial vibration component for assessment purposes where axial vibration calculation results of the complete dynamic system (engine/shafting/gearing/propeller) are not available. Where axial vibration calculation results of the complete dynamic system are available, the calculated values may be used instead.

5 Calculation of equivalent alternating stress

5.1 General

5.1.1 In the fillets, bending and torsion lead to two different biaxial stress fields which can be represented by a von Mises equivalent stress with the additional assumptions that bending and torsion stresses are time-phased and the corresponding peak values occur at the same location.

As a result, the equivalent alternating stress is to be calculated for the crankpin fillet as well as for the journal fillet, using von Mises criterion.

At the oil hole outlet, bending and torsion lead to two different stress fields which can be represented by an equivalent principal stress equal to the maximum of principal stress resulting from combination of these two stress fields with the assumption that bending and torsion are time-phased.

The above two different ways of equivalent stress evaluation both lead to stresses which may be compared to the same fatigue strength value of crankshaft assessed according to von Mises criterion.

5.2 Equivalent alternating stresses

5.2.1 The equivalent alternating stresses, in N/mm², are calculated according to the following formulae:

a) equivalent alternating stress σ'_V in way of crankpin fillet:

$$\sigma'_V = \pm\sqrt{(\sigma_{BH} + \sigma_{add})^2 + 3\tau_H^{\,2}}$$

b) equivalent alternating stress σ''_V in way of journal fillet:

$$\sigma''_V = \pm\sqrt{\sigma_{BG} + \sigma_{add}^{\,2} + 3\tau_G^{\,2}}$$

c) equivalent alternating stress σ'''_V in way of outlet of crankpin oil bore:

$$\sigma'''_V = \pm\frac{1}{3}\sigma_{BO}\left[1 + 2\sqrt{1 + \frac{9}{4}\left(\frac{\sigma_{TO}}{\sigma_{BO}}\right)^2}\right]$$

where:

σ_{add}, σ_{BG}, σ_{BH}, σ_{BO}, σ_{TO}, τ_G, τ_H : As defined in Symbols.

6 Calculation of fatigue strength

6.1

6.1.1 The fatigue strength is to be understood as that value of von Mises equivalent alternating stress which a crankshaft can permanently withstand at the most highly stressed points.

The fatigue strength may be evaluated by means of the following formulae:

a) allowable alternating bending fatigue strength of crankshaft σ'_{DW}, in N/mm², in the crankpin fillet area:

$$\sigma'_{DW} = \pm\, KR'_m\left(0{,}264 + \frac{1{,}073}{D^{0,2}} + \frac{785 - R_m}{4900} + \frac{196}{R_m}\sqrt{\frac{1}{R_H}}\right)$$

b) allowable alternating bending fatigue strength of crankshaft σ''_{DW}, in N/mm², in the journal fillet area:

$$\sigma''_{DW} = \pm\, KR'_m\left(0{,}264 + \frac{1{,}073}{D_G^{\,0,2}} + \frac{785 - R_m}{4900} + \frac{196}{R_m}\sqrt{\frac{1}{R_G}}\right)$$

c) allowable alternating bending fatigue strength of crankshaft σ'''_{DW}, in N/mm², in the crankpin oil bore area:

$$\sigma'''_{DW} = \pm\, KR'_m\left(0{,}264 + \frac{1{,}073}{D^{0,2}} + \frac{785 - R_m}{4900} + \frac{196}{R_m}\sqrt{\frac{2}{D_O}}\right)$$

where:

K : Factor equal to:

- for different types of crankshafts without surface treatment (values greater than 1,00 are only applicable to fatigue strength in fillet area):
  - K = 1,05 for continuous grain flow forged or drop-forged crankshafts
  - K = 1,00 for free form forged crankshafts (without continuous grain flow)
- for cast steel crankshafts with cold rolling treatment in fillet area:
  - K = 0,93 for cast steel crankshafts manufactured by companies using a cold rolling process approved by the Society

$R'_m = 0{,}42\, R_m + 39{,}3$

R_m, D, D_G, D_O, R_G, R_H : As defined in Symbols.

When a surface treatment process is applied, it is to be approved by the Society.

These formulae are subject to the following conditions:

- surfaces of the fillet, the outlet of the oil bore and inside the oil bore (down to a minimum depth equal to 1,5 times the oil bore diameter) are to be smoothly finished
- for calculation of σ'_{DW}, σ''_{DW} and σ'''_{DW}, the values of R_G, R_H and $D_O/2$ are to be taken as not less than 2 mm.

As an alternative, the fatigue strength of the crankshaft can be determined by experiment based either on full size crank throw (or crankshaft) or on specimens taken from a full size crank throw.

In any case, the experimental procedure for fatigue evaluation of specimens and fatigue strength of crankshaft assessment have to be submitted for approval to the Society: method, type of specimens, number of specimens (or crank throws), number of tests, survival probability, confidence number, ...

7 Acceptability criteria

7.1

7.1.1 The sufficient dimensioning of a crankshaft is confirmed by a comparison of the equivalent alternating stress and the fatigue strength. This comparison has to be carried out for the crankpin fillet, the journal fillet, the outlet of crankpin oil bore and is based on the following acceptability factors Q_i :

$$Q_1 = \frac{\sigma'_{DW}}{\sigma'_V}$$

$$Q_2 = \frac{\sigma''_{DW}}{\sigma''_V}$$

$$Q_3 = \frac{\sigma'''_{DW}}{\sigma'''_V}$$

Adequate dimensioning of the crankshaft is ensured if these acceptability factors satisfy the criterion:

$Q_i \geq 1{,}15$ with i = 1 to 3

8 Calculation of shrink-fits of semi-built crankshaft

8.1 General

8.1.1 Respecting the radius of the transition R_G from the journal diameter D_G to the shrink diameter D_S , the following criterion is to be complied with:

$R_G \geq Max\ (0{,}015\ D_G\ ;\ 0{,}5\ (D_S - D_G))$

The actual oversize Z of the shrink-fit is to be within the limits Z_{min} and Z_{max} calculated in accordance with [8.3] and [8.4].

In the case where the condition in [8.2] cannot be fulfilled then calculation methods of Z_{min} and Z_{max} according to [8.3] and [8.4] are not applicable due to multizone-plasticity problems.

In such a case, Z_{min} and Z_{max} have to be established based on FEM calculations.

8.2 Maximum permissible hole in journal pin

8.2.1 The hole diameter in the journal pin D_{BG} , in mm, is to satisfy the following criterion:

$$D_{BG} \leq D_S \sqrt{1 - \frac{4000 \cdot S_R \cdot M_{max}}{\mu \cdot \pi \cdot D_S^{\ 2} \cdot L_S \cdot R_{SP}}}$$

where:

D_S , L_S : As defined in Symbols

S_R : Safety factor against slipping, however a value not less than 2 is to be taken unless documented by experiments

M_{max} : Absolute maximum value of the torque M_{Tmax} (see Symbols), in N·m

μ : Coefficient for static friction, however a value not greater than 0,2 is to be taken unless documented by experiments

R_{SP} : Minimum yield strength of material for journal pin, in N/mm².

This condition serves to avoid plasticity in the hole of the journal pin.

8.3 Necessary minimum oversize of shrink-fit

8.3.1 The necessary minimum oversize Z_{min} of the shrink-fit, in mm, is determined by the greater value calculated according to:

$$Z_{min} \geq \frac{R_{SW} \cdot D_S}{E_m}$$

and

$$Z_{min} \geq \frac{4000}{\pi \cdot \mu} \cdot \frac{S_R \cdot M_{max}}{E_m \cdot D_S \cdot L_S} \cdot \frac{1 - \left(\frac{D_S}{D_A}\right)^2 \cdot \left(\frac{D_{BG}}{D_S}\right)^2}{\left[1 - \left(\frac{D_S}{D_A}\right)^2\right] \cdot \left[1 - \left(\frac{D_{BG}}{D_S}\right)^2\right]}$$

where:

R_{SW} : Minimum yield strength of material for crank web, in N/mm²

E_m : Young's modulus of material for crank web, in N/mm²

D_S , L_S , D_A , D_{BG} : As defined in Symbols

μ, S_R , M_{max} : As defined in [8.2.1].

8.4 Maximum permissible oversize of shrink-fit

8.4.1 The maximum permissible oversize Z_{max} of the shrink-fit, in mm, is calculated according to:

$$Z_{max} \leq \frac{R_{SW} \cdot D_S}{E_m} + \frac{0{,}8 D_S}{1000}$$

where:

R_{SW} , D_S , E_m : As defined in [8.3.1].

This condition concerning the maximum permissible oversize serves to restrict the shrinkage induced mean stress in the journal fillet.

9 Alternative method for calculation of stress concentration factors (SCF) in the web fillet radii of crankshafts by utilizing Finite Element Method

9.1 General

9.1.1 The objective of the analysis is to develop Finite Element Method (FEM) calculated figures as an alternative to the analytically calculated stress concentration factors (SCF) at the crankshaft fillets. The analytical method is based on empirical formulae developed from strain gauge measurements of various crank geometries and accordingly the application of these formulae is limited to those geometries.

The SCFs calculated according to this Appendix are defined as the ratio of stresses calculated by FEM to nominal stresses in both journal and pin fillets. When used in connection with the method of the present Article [9] or with the alternative methods, von Mises stresses shall be calculated for bending and principal stresses for torsion.

The procedure, as well as evaluation guidelines, are valid for both solid cranks and semi-built cranks (except journal fillets).

The analysis is to be conducted as linear elastic FE analysis, and unit loads of appropriate magnitude are to be applied for all load cases.

The calculation of SCF at the oil bores is not covered by this Appendix.

It is advised to check the element accuracy of the FE solver in use, e.g. by modeling a simple geometry and comparing the stresses obtained by FEM with the analytical solution for pure bending and torsion.

Boundary Element Method (BEM) may be used instead of FEM.

9.2 Model requirements

9.2.1 The basic recommendations and perceptions for building the FE-model are presented in [9.2.2]. It is obligatory for the final FE-model to fulfill the requirement in [9.2.4].

9.2.2 Element mesh recommendations

In order to fulfil the mesh quality criteria it is advised to construct the FE model for the evaluation of Stress Concentration Factors according to the following recommendations:

a) The model consists of one complete crank, from the main bearing centreline to the opposite side main bearing centreline

b) Element types used in the vicinity of the fillets:

- 10 node tetrahedral elements
- 8 node hexahedral elements
- 20 node hexahedral elements

c) Mesh properties in fillet radii

The following applies to ±90 degrees in circumferential direction from the crank plane:

- Maximum element size a = r / 4 through the entire fillet as well as in the circumferential direction.

  When using 20 node hexahedral elements, the element size in the circumferential direction may be extended up to 5 a.

  In the case of multi-radii fillet, r is the local fillet radius.

  If 8 node hexahedral elements are used even smaller element size is required to meet the quality criteria

- Recommended manner for element size in fillet depth direction:
  - 1rst layer thickness equal to element size of a
  - 2nd layer thickness equal to element size of 2 a
  - 3rd layer thickness equal to element size of 3 a
- Minimum 6 elements across web thickness

d) Generally the rest of the crank should be suitable for numeric stability of the solver

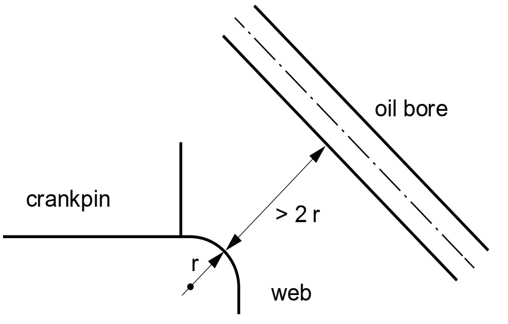
e) Counterweights have to be modeled only when influencing the global stiffness of the crank significantly

f) Modeling of oil drillings is not necessary as long as the influence on global stiffness is negligible and the proximity to the fillet is more than 2 r (see Fig 6)

g) Drillings and holes for weight reduction have to be modeled

h) Sub-modeling may be used as far as the software requirements are fulfilled.

Figure 6 : Oil bore proximity to fillet



9.2.3 Material

The present Appendix does not consider material properties such as Young's Modulus (E) and Poisson's ratio (ν). In FE analysis, those material parameters are required, as strain is primarily calculated and stress is derived from strain using the Young's Modulus and Poisson's ratio.

Reliable values for material parameters have to be used, either as quoted in literature or as measured on representative material samples.

For steel, the following values are advised:

$E = 2{,}05\ 10^5$ MPa and $\nu = 0{,}3$

9.2.4 Element mesh quality criteria

If the actual element mesh does not fulfil any of the following criteria at the examined area for SCF evaluation, then a second calculation with a refined mesh is to be performed:

- Principal stress criterion

  The quality of the mesh should be assured by checking the stress component normal to the surface of the fillet radius. Ideally, this stress should be zero. With principal stresses σ_1, σ_2 and σ_3, the following criterion is required:

  $\text{Min}\,(|\sigma_1|\ ;\ |\sigma_2|\ ;\ |\sigma_3|) < 0{,}03\ \text{Max}\,(|\sigma_1|\ ;\ |\sigma_2|\ ;\ |\sigma_3|)$

- Averaged / unaveraged stress criterion

  The criterion is based on observing the discontinuity of stress results over elements at the fillet for the calculation of SCF.

  Unaveraged nodal stress results calculated from each element connected to a node i should differ less than by 5% from the 100% averaged nodal stress results at this node i at the examined location.

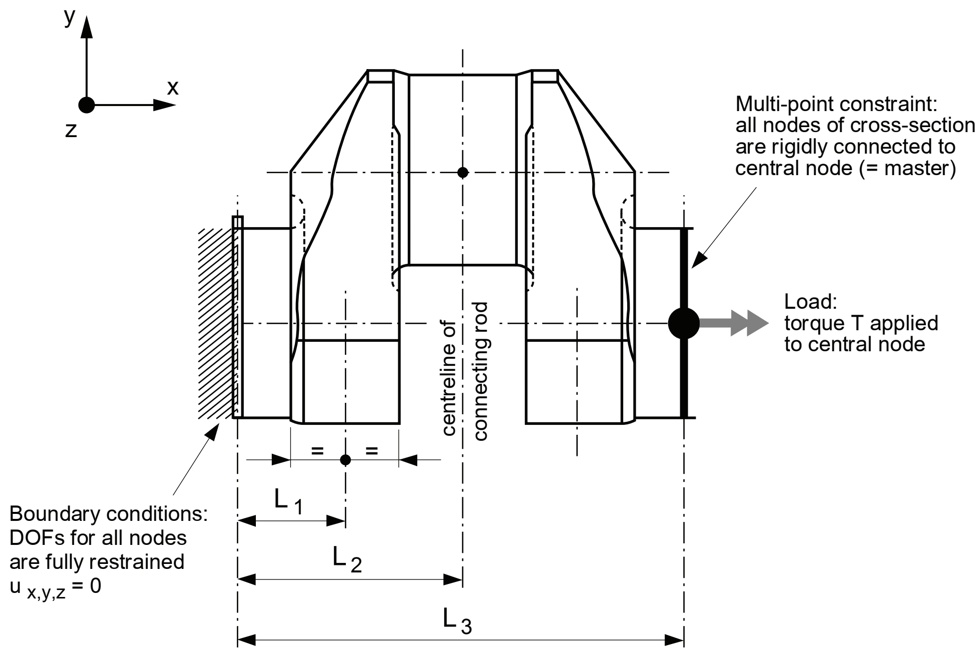
9.3 Load cases

9.3.1 To substitute the analytically determined SCF in this Appendix, the following load cases have to be calculated.

9.3.2 Torsion

In analogy to the testing apparatus used for the investigations made by FVV, the structure is loaded in pure torsion. In the model, surface warp at the end faces is suppressed.

Figure 7 : Boundary and load conditions for the torsion load case



Torque is applied to the central node located at the crankshaft axis. This node acts as the master node with 6 degrees of freedom and is connected rigidly to all nodes of the end face.

Boundary and load conditions (see Fig 7) are valid for both in-line and V-type engines.

For all nodes in both the journal and crank pin fillets, principal stresses are extracted and the equivalent torsional stress τ_{equiv} is calculated:

$$\tau_{equiv} = \mathrm{Max}\left(\frac{|\sigma_1 - \sigma_2|}{2}\ ;\ \frac{|\sigma_2 - \sigma_3|}{2}\ ;\ \frac{|\sigma_1 - \sigma_3|}{2}\right)$$

The maximum value for crankpin fillet $\tau_{equiv,\,\alpha}$ and for journal fillet $\tau_{equiv,\,\beta}$ is used for the subsequent calculation of the SCF α_T and β_T :

$$\alpha_T = \frac{\tau_{equiv,\,\alpha}}{\tau_{NH}}$$

$$\beta_T = \frac{\tau_{equiv,\,\beta}}{\tau_{NG}}$$

where:

τ_{NH} , τ_{NG} : Nominal torsional stresses, in N/mm^2, referred to the crankpin and the journal, respectively, and calculated as per [2.2.2] with the torsional torque T (see Fig 7):

$$\tau_{NH} = \pm\frac{T}{W_{PH}} \cdot 10^3$$

$$\tau_{NG} = \pm\frac{T}{W_{PG}} \cdot 10^3$$

9.3.3 Pure bending (4-point bending)

In analogy to the testing apparatus used for the investigations made by FVV, the structure is loaded in pure bending. In the model, surface warp at the end faces is suppressed.

The bending moment is applied to the central node located at the crankshaft axis. This node acts as the master node with 6 degrees of freedom and is connected rigidly to all nodes of the end face.

Boundary and load conditions (see Fig 8) are valid for both in-line- and V- type engines.

For all nodes in both the journal and crankpin fillets, von Mises equivalent stresses σ_{equiv} are extracted.

The maximum value for crankpin fillet $\sigma_{equiv,\,\alpha}$ and for journal fillet $\sigma_{equiv,\,\beta}$ is used for the subsequent calculation of the SCF α_B and β_B:

$$\alpha_B = \frac{\sigma_{equiv,\,\alpha}}{\sigma_N}$$

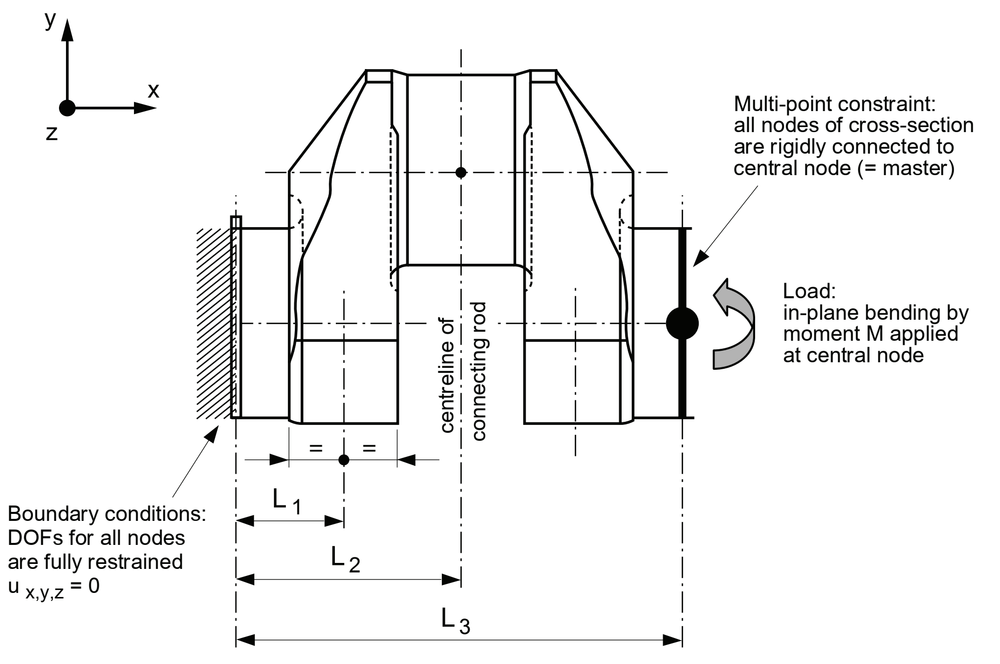
$$\beta_B = \frac{\sigma_{equiv,\,\beta}}{\sigma_N}$$

where:

σ_N : Nominal bending stress, in N/mm^2, related to the web cross-section and calculated as per [2.1.2] item b) with the bending moment M (see Fig 8):

$$\tau_N = \pm\frac{M}{W_{eqw}} \cdot 10^3$$

Figure 8 : Boundary and load conditions for the pure bending load case



9.3.4 Bending with shear force (3-point bending)

This load case is calculated to determine the SCF for pure transverse force (radial force, β_Q) for the journal fillet.

In analogy to the testing apparatus used for the investigations made by FVV, the structure is loaded in 3-point bending. In the model, surface warp at the both end faces is suppressed.

All nodes are connected rigidly to the central node; boundary conditions are applied to the central nodes. These nodes act as master nodes with 6 degrees of freedom.

The force is applied to the central node located at the pin centreline of the connecting rod. This node is connected to all nodes of the pin cross-sectional area. Warping of the sectional area is not suppressed.

Boundary and load conditions are valid for in-line engines (see Fig 9) and V-type engines. V-type engines can be modeled with one connecting rod force only. Using two connecting rod forces will make no significant change in the SCF.

The maximum equivalent von Mises stress σ_{3P} in the journal fillet is evaluated. The SCF in the journal fillet can be determined with one of the two following methods:

a) Method 1

This method is analogue to the FVV investigation. The results from 3-point and 4-point bending are combined as follows:

$$\sigma_{3P} = \sigma_{N3P}\,\beta_B + \sigma_{Q3P}\,\beta_Q$$

where:

σ_{3P} : As found by the FE calculation

σ_{N3P} : Nominal bending stress in the web centre due to the force F_{3P}, in N, applied to the centreline of the actual connecting rod (see Fig 10)

β_B : SCF as determined in [9.3.3]

$$\sigma_{Q3P} = \frac{Q_{3P}}{BW}$$

with:

Q_{3P} : Radial (shear) force in the web due to the force F_{3P}, in N, applied to the centreline of the actual connecting rod (see also Fig 2).

b) Method 2

This method is not analogous to the FVV investigation. In a statically determined system with one crank throw supported by two bearings, the bending moment and radial (shear) force are proportional. Therefore the SCF in the journal fillet can be found directly by the 3-point bending FE calculation.

The SCF is then calculated according to:

$$\beta_{BQ} = \frac{\sigma_{3P}}{\sigma_{N3P}}$$

where:

σ_{3P}, σ_{N3P} : As defined in item a) above.

When using this method, the radial force and stress determination in this Appendix becomes superfluous. The alternating bending stress in the journal fillet as per [2.1.3] is then evaluated:

$$\sigma_{BG} = \pm\,|\beta_{BQ}\cdot\sigma_{BFN}|$$

Note 1: The use of this method does not apply to the crankpin fillet and this SCF must not be used in connection with calculation methods other than those assuming a statically determined system as in this Appendix.

Figure 9 : Boundary and load conditions for the 3-point bending load case of an in-line engine

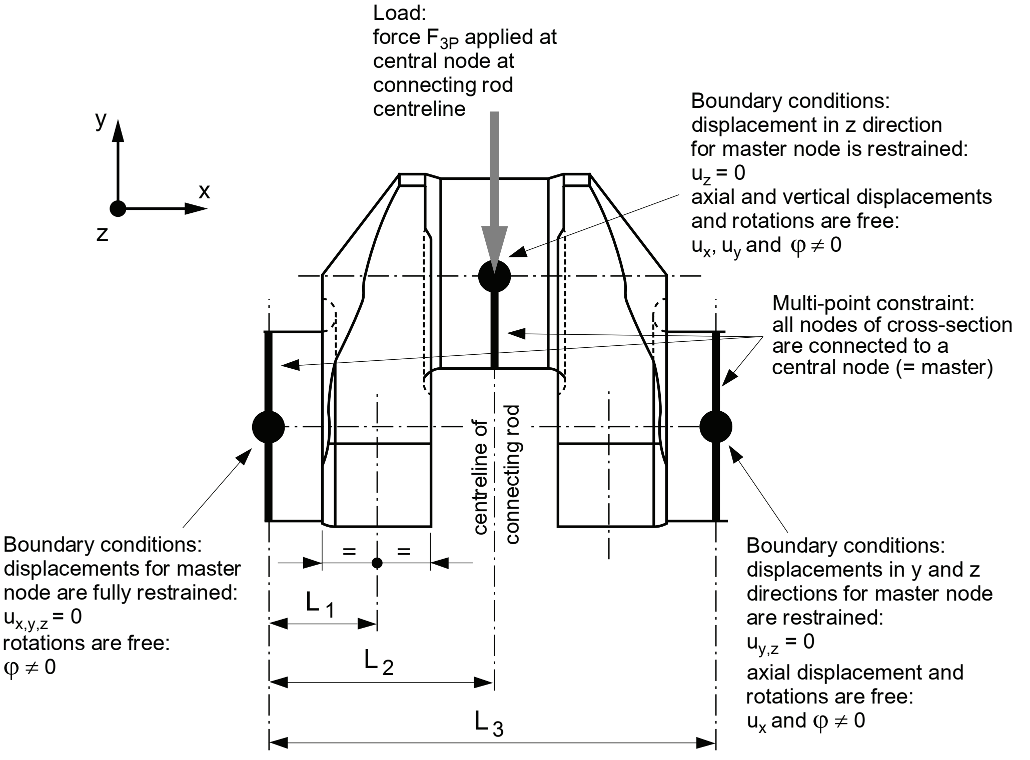
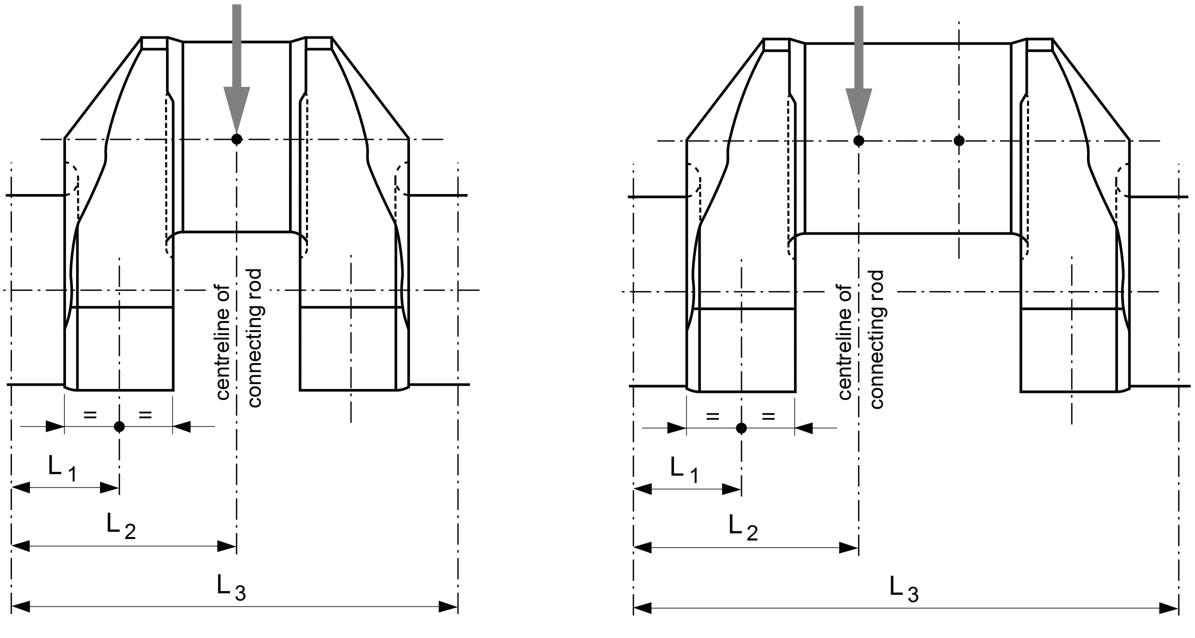


Figure 10 : Load applications for in-line and V-type engines



APPENDIX 2 DESIGN OF DUAL FUEL ENGINES AND DUAL FUEL GAS TURBINES

1 General

1.1 Scope

1.1.1 This Appendix covers the specific features of Dual Fuel (DF) diesel engines and Dual Fuel (DF) gas turbines.

The requirements of:

- Ch 1, Sec 2, for diesel engines
- Ch 1, Sec 5, for gas turbines

are also to be complied with.

1.1.2 This Appendix applies to 4-stroke dual fuel engines supplied with gas at a pressure not exceeding 10 bar. The acceptance of 2-stroke dual fuel engines may be considered on a case by case basis.

1.2 Design principles

1.2.1 DF diesel engines and DF gas turbines are to be type-approved by the Society. The type tests are to be carried out according to an approved program.

1.2.2 DF diesel engines and DF gas turbines are to be designed so as to operate safely with any gas composition within the ship specification range, taking into account the possible variations of the gas composition during the voyage. Tests are to be carried out to demonstrate their ability in this respect.

1.2.3 Arrangements are to be made to ensure that under no circumstances introduction of liquid gas in the DF diesel engine or DF gas turbine may occur.

1.2.4 The fuel supply is to be capable of being switched over from gas fuel to oil fuel while the engine or turbine is running, without significant fluctuation of the engine or turbine output nor of the rotational speed.

1.2.5 Prior to a normal stop, the engine or turbine is to be switched over from gas fuel to oil fuel.

1.2.6 After each gas operation of the engine or turbine not followed by an oil fuel operation, the engine or turbine including the exhaust system is to be purged during a sufficient time in order to discharge the gas which may be present.

1.2.7 DF engines and DF gas turbines are to be fitted with a control system allowing a steady running with stable combustion, with any kind of gas as mentioned in [1.2.2] above, throughout the operating speed range of the engine or turbine. Automatic switch over to oil fuel may however be accepted at low loads.

1.2.8 Gas fuel and oil fuel supply systems pertaining to DF engines and DF gas turbines are to be so designed and controlled as to avoid any excessive gas delivery to the engine or gas turbine, which may result in the engine overspeed, in particular while the engine or gas turbine is running with gas fuel and oil fuel at the same time.

2 Additional requirements for dual fuel engines

2.1 Air inlet manifolds

2.1.1 Air inlet manifolds are to be provided with relief valves or other approved devices, the size, number and distribution of which are to be justified.

Note 1: The relief valves or equivalent devices may be omitted in the following cases, subject to satisfactory justifications:

- the strength of the air inlet manifold is sufficient to withstand the pressure build-up due to the worst-case explosion, or
- the maximum gas concentration expected in the air inlet manifold in case of malfunction of a gas admission valve, leakage of an air inlet valve, etc. cannot reach dangerous levels.

2.1.2 Where provided, explosion relief valves or equivalent devices are to be so arranged and located as to minimize the consequences of a flame emission.

2.1.3 Any electric equipment located in the inlet air manifold is to be of the intrinsically safe type.

2.2 Gas supply to the cylinders

2.2.1 Gas is normally to be introduced directly in or as close as possible to the cylinders heads.

2.2.2 Gas may also be introduced in the air manifold provided that:

- the gas concentration of the gas/air mixture in the air manifold may under no circumstances exceed 60% of the lower flammable limit. A gas detector is to be provided for that purpose
- gas may not pass from the air manifold to the exhaust system
- excessive gas supply to the engine likely to result in overspeed is precluded.

Note 1: The following failures are to be considered in the risk analysis:

- malfunction of the gas admission valve
- leaking cylinder inlet/exhaust valves.

2.2.3 The gas manifold is to be fitted with a flame arrester at the engine inlet, unless it is demonstrated that the gas supply system is so designed as to prevent the passage of flame into the gas piping.

2.3 Gas Ignition in the cylinders

2.3.1 In order to initiate the gas combustion, each cylinder is to be fitted with a pilot injection system supplied with liquid fuel and continuously operated. Other systems, such as spark ignition, will be subject to a special examination.

2.4 Exhaust manifold

2.4.1 Exhaust manifolds are to be of reinforced construction and provided with safety valves or other approved devices, the size, number and distribution of which are to be justified.

Note 1: Where the strength of the exhaust manifold is sufficient to withstand the pressure build-up due to the worst-case explosion, the relief valves or equivalent devices may be omitted.

2.4.2 In the case where an analysis showing that the gas concentration within the exhaust manifold cannot reach dangerous levels is submitted to the Society, the provisions of [2.4.1] may be waived. This analysis is to cover at least the malfunction of a cylinder (misfiring) and an exhaust valve leakage.

2.5 Crankcase

2.5.1 The crankcase is to be equipped with a sensor to detect an overpressure due to a piston ring failure (blow-by).

2.5.2 Owing to the continuous presence of gas in the crankcase due to the operating principle of the engine (compression of a gas/air mixture), a temperature monitoring system approved by the Society is to be provided for each part of the engine subjected to friction in order to detect any abnormal temperature rise likely to result in the gas ignition.

The temperature monitoring system is to be provided in particular for the cylinder liners, main bearings and connecting rod big end bearings. In case of abnormal temperature rise, this system is to activate the immediate shut-down of the engine.

The temperature sensors and other components of the temperature monitoring system located within the crankcase are to be of the safe type, suitable for use in explosive atmosphere.

Note 1: Arrangements other than direct temperature measurements, such as:

- hot spot detection systems based on other principles, or
- justifications submitted by the engine manufacturer and showing that the engine components subjected to friction are under no circumstances likely to be brought to dangerous temperatures which may result in crankcase gas ignition

may be taken into consideration if, in the opinion of the Society, they present an equivalent safety level. Oil mist detection systems, which are required to be fitted on ships having an automation notation, will normally not be accepted for this purpose.

2.5.3 Crankcase vent lines are to be fitted with a sampling line allowing the measurement of the gas concentration in the crankcase by means of a portable measuring device.

2.5.4 Arrangements are to be made to allow the inerting of the crankcase before servicing of the engine.

2.6 Instrumentation and safeties

2.6.1 The engine control system as well as the related systems are to be of a type approved by the Society.

2.6.2 The alarm and safety systems are to be provided in accordance with Tab 1.

2.6.3 Gas admission valves are to be fitted with a device allowing the immediate detection of a malfunction (such as locking in open position).

2.6.4 The combustion in each cylinder is to be monitored for the detection of possible misfiring or knocking.

Note 1: When the gas is introduced in the air inlet manifold in accordance with [2.2.2], only one cylinder needs to be monitored for knocking detection.

3 Additional requirements for dual fuel gas turbines

3.1 General

3.1.1 The turbine and associated gas treatment and gas supply systems as well as their control system are to be so designed and arranged as to allow the proper operation of the turbine taking into account the expected variations of the gas characteristics, in particular:

- Lower heating value
- Specific gravity
- Gas temperature
- Ambient temperature.

3.2 Protection against liquid presence in the gas supply

3.2.1 Arrangements are to be made to avoid the condensation of heavy hydrocarbons or water in the turbine gas inlet system. Where this is achieved by heating the gas fuel, a superheat of at least 28°C above the dew point is to be observed to ensure that that no liquid may appear in the gas system downstream of the heater.

3.2.2 Where necessary, the gas piping system is to be heat traced to avoid any condensation, in particular during the turbine start-up.

3.3 Instrumentation and safeties

3.3.1 The turbine control system as well as the related systems are to be of a type approved by the Society.

3.3.2 The alarm and safety systems are to be provided in accordance with Tab 2.

Table 1 : Dual fuel diesel engine alarm and safety systems

Parameter	Alarms	Automatic safety actions			
		Activation of the block-and-bleed valves	Activation of the master gas valve	Switch over to oil fuel mode	Engine shut down
Gas supply - pressure	L+H	X		X	
Gas supply - temperature	L+H	X		X	
Gas admission valve(s) - failure	X	X		X	
Pilot injection system - failure	X	X		X	
Air inlet manifold - gas concentration reaching 60% LFL **(1)**	H	X		X	
Exhaust gas at each cylinder outlet - temperature	H	X		X	
Exhaust gas at each cylinder outlet - temperature deviation from average	H	X		X	
Combustion in each cylinder - misfiring	X	X		X	
Combustion in each cylinder - knocking	X	X		X	
Crankcase - pressure	H	X			X
Crankcase - temperature **(2)**	H	X			X
Crankcase - oil mist concentration	H	X			X
Engine stop from any cause	X	X			

(1) Required only when gas is introduced directly in the gas manifold in accordance with [2.2.2].
(2) High temperature of cylinder liners or bearings. See [2.5.2].
Note 1: Symbol convention: H = High, L = Low, X = function is required

Table 2 : Dual fuel gas turbine alarm and safety systems

Parameter	Alarms	Automatic safety actions			
		Activation of the block-and-bleed valves	Activation of the master gas valve	Switch over to oil fuel mode	Engine shut down
Gas supply - abnormal pressure	L+H	X		X	
Gas supply - abnormal temperature	L+H	X		X	
Gas admission valve - failure	X	X		X	
Turbine stop from any cause	X	X			

Note 1: Symbol convention: H = High, L = Low, X = function is required

CHAPTER 2

(Amendments July 2015)

Replace "convertor" or "convertors" respectively by "converter" or "converters" in Section 1, Section 3, Section 6, Section 8 and from Section 11 to Section 15.

Ch 2, Sec 1, [1.2] (Amendments July 2015)

Replace requirement [1.2.2] by:

1.2.2 When referred to by the Society, publications by the International Electrotechnical Commission (IEC) or other internationally recognised standards defined in this Chapter, are in principle those currently in force at the date of the contract for construction.

Note 1: The use of previous versions of these standards will be considered on case by case basis.

Ch 2, Sec 1, [3.25.1]

Replace item a) in the alphanumeric list of requirement [3.25.1] by:

a) machinery spaces as defined in Ch 4, Sec 1, [3.24], except spaces having little or no fire risk as defined by category (10) of Ch 4, Sec 5, [1.3.4] item b) 2)

Ch 2, Sec 2 (Amendments July 2015)

Replace Table 2 by:

Table 2 : Humidity

Location	Humidity
General	95% up to 45°C 70% above 45°C
Air conditioned areas	Different values may be considered on a case-by-case basis

Ch 2, Sec 2, [5.2] (Amendments July 2015)

Replace requirement [5.2.3] by:

5.2.3 For cable entries, see [5.1.5].

Ch 2, Sec 3, [2.4.2] (Amendments July 2015)

Add the following Note 1 at the end of requirement [2.4.2]:

Note 1: Pt E, Ch 3, Sec 1, Tab 28 applies.

Ch 2, Sec 3, [9.2.3] (Amendments July 2015)

Replace "PVC insulated cables" by "PVC-ST2 insulated cables" at the beginning of requirement [9.2.3].

Ch 2, Sec 3, [9.6.2]

Replace item a) in the alphanumeric list of requirement [9.6.2] by:

a) Cables being of a fire resistant type complying with IEC 60331 for cables of greater than 20 mm overall diameter, otherwise IEC 60331-21 or IEC 60331-2 for cables with an overall diameter not exceeding 20 mm, are to be installed and run continuous to keep the fire integrity within the high fire risk area (see Fig 4)

Note 1: The application of this requirement for public spaces containing furniture and furnishings of other than restricted fire risk and having a deck area of 50 m^2 or more will be considered on the case by case basis.

Ch 2, Sec 6, [1.1] (Amendments January 2015)

Insert the following requirements [1.1.2], [1.1.3] and [1.1.4]:

1.1.2 The design of semi-conductor converters is to comply with the requirements of IEC Publication 60146-1-1 with applicable requirements modified to suit marine installations like e.g. environmental requirements stated in Pt C, Ch 2, Sec 2.

1.1.3 The design of semi-conductor converters for power supply is to comply with the requirements of IEC 62040 serie (see Article [2]).

1.1.4 The design of semi-conductor converters for motor drives is to comply with the requirements of IEC 61800 serie.

Ch 2, Sec 9, [1.1.6] (Amendments July 2015)

Replace "PVC- or rubber-insulated" by "PVC-ST2 or rubber-insulated" in the first paragraph of requirement [1.1.6].

Ch 2, Sec 9, [1.3.1] (Amendments July 2015)

Replace "IEC Publication 60092-351" by "IEC Publication 60092-360" in requirement [1.3.1].

Ch 2, Sec 9, [1.5.4] (Amendments July 2015)

Replace "IEC Publication 60092-359" by "IEC Publication 60092-360" in requirement [1.5.4].

Ch 2, Sec 10 (Amendments July 2015)

Insert the following Article [2] and add the following Table 1, Table 2, Table 3 and Table 4:

2 Electrical slip ring assemblies

2.1 Construction

2.1.1 The purpose of an electrical slip ring is to form a continuous electrical connection between cables that are fixed to a stationary structure and cables fixed to a rotating structure.

2.1.2 Enclosure and connections are to be made of corrosion resistant materials.

2.1.3 If an oil production pipe passes through the central annulus of the electrical slip ring, it is to be verified that the ambient temperature in the slip ring enclosure does not exceed 45°C. Otherwise special precautions are to be considered.

2.2 Testing

2.2.1 General

Electric slip rings intended for essential services are to be subjected to the tests stated in Tab 1.

Type tests are to be carried out, unless the manufacturer can produce evidence based on previous experience indicating the satisfactory performance of such equipment onboard ships.

The manufacturer is to issue the relative test reports providing information concerning the construction, type, serial number and all other technical data relevant to the slip ring, as well as the results of the tests required.

Such test reports are to be made available to the Society.

Tests procedure is to be submitted to the Society for approval.

Tests of electric slip ring intended for essential services are to be attended by a Surveyor of the Society.

Table 1 : Tests to be carried out on electrical slip rings

N°	Tests	Type test **(1)**	Routine test **(2)**
1	Examination of the technical documentation, as appropriate, and visual inspection **(3)** including check of protection index, clearances and creepage distances	X	X
2	Torque measurement test	X	X
3	Insulation resistance measurement	X	X
4	Dielectric strength test	X	X
5	Continuity test	X	X
6	Resistance test (or attenuation test for optical fibre slip rings)	X	X
7	Rotational test	X	X
8	Environmental type test (cold, dry heat, damp heat, salt mist, vibration) **(4)**	X	

(1) Type test on prototype slip ring or test on at least the first batch of slip rings
(2) The certificates of slip rings routine tested are to contain the manufacturer's serial number of the slip ring which has been type tested and the test result
(3) A visual examination is to be made of the convertor to ensure, as far as practicable, that it complies with technical documentation
(4) Depending on the installation on board, some environmental tests may not be required, on the case-by-case basis.

2.3 Description of tests

2.3.1 Visual inspection

It is to be verified that the electrical slip ring assembly:

- complies with the approved drawings
- maintains the prescribed degree of protection
- is constructed in accordance with the relevant constructional requirements, in particular as regards creepage and clearance distances.

2.3.2 Insulation resistance measurement

Immediately after the high voltage tests the insulation resistances are to be measured using a direct current insulation tester between:

a) all current carrying parts connected together and earth

b) all current carrying parts of different polarity or phase.

The minimum values of test voltages and corresponding insulation resistances are given in Tab 2.

Table 2 : Minimum insulation resistance

Rated voltage Un (V)	Minimum test voltage (V)	Minimum insulation resistance (MΩ)
Un = 250	2 Un	1
250 < Un ≤ 1000	500	1
1000 < Un ≤ 7200	1000	Un/1000 + 1
7200 < Un ≤ 15000	5000	Un/1000 + 1

2.3.3 Dielectric strength test

Slip ring assemblies are to be subjected to a high voltage test between the polarities and between live parts and the enclosure.The test voltage is to be as given in Tab 3 and Tab 4. The test voltage is to be applied for 1 minute at any frequency between 25 and 100 Hz of approximately sinusoidal form.

No break down should occur during the test.

2.3.4 Torque measurement test

The purpose of this test is to measure and record the running and break-out torque of the electrical slip ring assembly. Test is to be carried out on the full 360° in both clockwise and anti-clockwise directions. Measured values are not to exceed data given by manufacturer.

Table 3 : Test voltages for main circuits

Rated insulation voltage Ui (V)	Test voltage a.c. (r.m.s.) (V)
Ui ≤ 60	1000
60 < Ui ≤ 300	2000
300 < Ui ≤ 660	2500
660 < Ui ≤ 800	3000
800 < Ui ≤ 1000	3500
1000 < Ui ≤ 3600	10.000
3600 < Ui ≤ 7200	20.000
7200 < Ui ≤ 12000	28.000

Table 4 : Test voltage for auxiliary circuits

Rated insulation voltage Ui (V)	Test voltage a.c. (r.m.s.) (V)
Ui ≤ 12	250
12 < Ui ≤ 60	500
Ui > 60	2 Ui + 1000 (at least 1500)

2.3.5 Continuity test

The purpose of this test is to ensure the continuous connection of each passes while the slip ring is rotating in both directions. No transitional discontinuity is to be detected.

2.3.6 Resistance or attenuation test

The purpose of this test is to measure the maximum resistance or the maximum attenuation of each pass while slip ring is rotating. Test is to be carried out between the inlet and outlet connection of the slip ring assembly on the full 360° in both clockwise and anti-clockwise directions. Values are not to exceed data given by manufacturer.

2.3.7 Rotational test

A rotational test at rated voltage and rated current is to be carried out. Number of rotations is to be evaluated taking into consideration the intended purpose of the slip ring. An endurance test is to be performed following manufacturer recommendations.

Ch 2, Sec 11, [5.2]

Insert the following requirement [5.2.3]:

5.2.3 The electrical cables to the emergency fire pump are not to pass through the machinery spaces containing the main fire pumps and their source(s) of power and prime mover(s). They are to be of a fire resistant type, in accordance with Sec 3, [9.6.2] item a), where they pass through other high fire risk areas.

Ch 2, Sec 12, [7.19] (Amendments July 2015)

Replace requirement [7.19.1] by:

7.19.1 Cable trays or protective casings made of plastics materials (thermoplastic or thermosetting plastic materials) are to be type-approved or case-by-case approved.

Ch 2, Sec 13, [3.3.1] (Amendments January 2015)

Delete "high frequency" in requirement [3.3.1].

Ch 2, Sec 14, [7] (Amendments July 2015)

Replace sub-article [7.2] by:

7.2 Electrical slip ring assemblies

7.2.1 Electrical slip ring assemblies are to comply with Ch 2, Sec 10, [2].

Ch 2, Sec 15, [2.1.1] (Amendments July 2015)

Add the following item at the end of the bullet list of requirement [2.1.1]:

- cable trays or protective casings made of plastics materials (thermoplastic or thermosetting plastic materials).

CHAPTER 3

Ch 3, Sec 2, [6.1] (Amendments July 2015)

Replace requirement [6.1.4] by:

6.1.4 When valves are remote controlled, a secondary manual means of operating them is to be provided (see Ch 1, Sec 10, [2.7.3]).

Ch 3, Sec 6, [2.1.1]

Replace requirement [2.1.1] as follow:

2.1.1 The following requirements are applicable, but not confined, to electrical, electronic and programmable equipment which are intended to be type approved for control, monitoring, alarm and protection systems for use in ships.

Ch 3, Sec 6, [2.2.2]

Add the following Note 1 at the end of requirement [2.2.2]:

Note 1: As used in this Section, and in contrast to a complete performance test, a functional test is a simplified test sufficient to verify that the equipment under test (EUT) has not suffered any deterioration caused by the individual environmental tests.

Ch 3, Sec 6, [2]

Delete sub-article [2.4]

Ch 3, Sec 6

Replace Table 1 by:

Table 1 : Type tests

No.	Test	Procedure **(6)**	Test parameters	Other information
1	Visual inspection	–	–	• drawings, design data
2	Performance test	Manufacturer performance test programme based upon specification and relevant rule requirements When the EUT is required to comply with an international performance standard, e.g. protection relays, verification of requirements in the standard are to be part of the performance testing required in this initial test and subsequent performance tests after environmental testing where required as per [2.2].	• standard atmosphere conditions • temperature: 25°C ± 10°C • relative humidity: 60% ± 30% • air pressure: 96 KPa ± 10 KPa	• confirmation that operation is in accordance with the requirements specified for particular automatic systems or equipment • checking of self-monitoring features • checking of specified protection against an access to the memory • checking against effect of unerroneous use of control elements in the case of computer systems
3	Power supply failure	–	• 3 interruptions during 5 minutes • switching- off time 30 s each case	• verification of the specified action of the equipment on loss and restoration of supply in accordance with the system design • verification of possible corruption of programme or data held in programmable electronic systems, where applicable • the time of 5 minutes may be exceeded if the equipment under test needs a longer time for start up, e.g. booting sequence • for equipment which requires booting, one additional power supply interruption during booting to be performed

No.	Test	Procedure **(6)**	Test parameters	Other information
4a	Electric A.C. power supply variations	–	COMBINATION Voltage variation permanent / Frequency variation permanent + 6% / + 5% + 6% / – 5% – 10% / – 5% – 10% / + 5% voltage transient / frequency transient 1,5 s / 5 s + 20% / + 10% – 20% / – 10%	
4b	Electric D.C. power supply variations	–	Voltage tolerance continuous: ± 10% Voltage cyclic variation: 5% Voltage ripple: 10% Electric battery supply: • +30% to –25% for equipment connected to charging battery or as determined by the charging/discharging characteristics, including ripple voltage from the charging device • +20% to –25% for equipment not connected to the battery during charging	
4c	Pneumatic and hydraulic power supply variations	–	Pressure: ± 20% Duration: 15 minutes	
5	Dry heat	IEC 60068-2-2	• Temperature: 55°C ± 2°C Duration: 16 hours, or • Temperature: 70°C ± 2°C Duration: 16 hours (see **(1)**)	• equipment operating during conditioning and testing • functional test **(9)** during the last hour at the test temperature • for equipment specified for increased temperature the dry heat test is to be conducted at the agreed test temperature and duration.
6	Damp heat	IEC 60068-2-30 Test Db	Temperature: 55°C Humidity: 95% Duration: 2 cycles (12 + 12 hours)	• measurement of insulation resistance before test • the test shall start with 25°C ± 3°C and at least 95% humidity • equipment operating during the complete first cycle and switched off during second cycle except for functional test • functional test during the first 2 hours of the first cycle at the test temperature and during the last 2 hours of the second cycle at the test temperature; Duration of the second cycle can be extended due to more convenient handling of the functional test • recovery at standard atmosphere conditions • insulation resistance measurements and performance test

No.	Test	Procedure **(6)**	Test parameters	Other information
7	Vibration	IEC 60068-2-6 Test Fc	• 2 Hz ± 3/0 Hz to 13,2 Hz amplitude: ± 1mm • 13,2 Hz to 100 Hz acceleration: ± 0,7 g For severe vibration conditions such as, e. g., on diesel engines, air compressors, etc.: • 2,0 Hz to 25 Hz amplitude: ± 1,6 mm • 25 Hz to 100 Hz acceleration: ± 4,0 g Note: More severe conditions may exist for example on exhaust manifolds or fuel oil injection systems of diesel engines. For equipment specified for increased vibration levels the vibration test is to be conducted at the agreed vibration level, frequency range and duration. Values may be required to be in these cases: • 40 Hz to 2000 Hz • acceleration: ± 10,0 g at 600°C	• duration 90 minutes at 30 Hz in case of no resonance condition • duration 90 minutes at each resonance frequency at which Q ≥ 2 is recorded • during the vibration test, functional tests are to be carried out • tests to be carried out in three mutually perpendicular planes • it is recommended as a guidance that Q does not exceed 5 • duration 120 minutes where sweep test is to be carried out instead of discrete frequency test and a number of resonant frequencies is detected close to each other. Sweep over a restricted frequency range between 0.8 and 1.2 times the critical frequencies can be used where appropriate. Note: Critical frequency is a frequency at which the equipment being tested may exhibit: • malfunction and/or performance deterioration • mechanical resonances and/or other response effects occur, e.g. chatter
8	Inclination	IEC 60092-504	Static 22,5°	a) inclined to the vertical at an angle of at least 22,5° b) inclined to at least 22,5° on the other side of the vertical and in the same plane as in a) c) inclined to the vertical at an angle of at least 22,5° in plane at right angles to that used in a) d) inclined to at least 22,5° on the other side of the vertical and in the same plane as in c) Note: The period of testing in each position should be sufficient to fully evaluate the behaviour of the equipment
			Dynamic 22,5°	Using the directions defined in a) to d) above, the equipment is to be rolled to an angle of 22,5° each side of the vertical with a period of 10 seconds The test in each direction is to be carried out for not less than 15 minutes Note: These inclination tests are normally not required for equipment with no moving parts.
9	Insulation resistance	Rated supply voltage / Test voltage (D.C. voltage) (V) Un ≤ 65 V / 2 x Un min. 24 V Un > 65V / 500 V	Minimum insulation resistance: before / after 10 Mohms / 1,0 Mohms 100 Mohms / 10 Mohms	• insulation resistance test is to be carried out before and after: damp heat test, cold test, salt mist test and high voltage test • between all phases and earth, and where appropriate between the phases Note: Certain components, e. g. for EMC protection, may be required to be disconnected for this test

No.	Test	Procedure **(6)**	Test parameters	Other information
10	High voltage	Rated voltage Un Up to 65 V 66 V to 250 V 251 V to 500 V 501 V to 690 V	Test voltage (A.C. voltage 50 or 60Hz) 2 x Un + 500 V 1500 V 2000 V 2500 V	• separate circuits are to be tested against each other and all circuits connected with each other tested against earth • printed circuits with electronic components may be removed during the test • period of application of the test voltage: 1 minute Note: Certain components, e. g. printed circuits with electronic components, may be required to be disconnected for this test
11	Cold	IEC 60068-2-1	• Temperature: +5°C ± 3°C Duration: 2 hours, or • Temperature: –25°C ± 3°C Duration: 2 hours (see **(2)**)	• initial measurement of insulation resistance • equipment not operating during conditioning and testing except for functional test • functional test during the last hour at the test temperature • insulation resistance measurement and the functional test after recovery
12	Salt mist	IEC 60068-2-52 Test Kb	Four spraying periods with a storage of seven days after each	• initial measurement of insulation resistance and initial functional test • equipment not operating during conditioning • functional test on the 7th day of each storage period • insulation resistance measurement and performance test 4 to 6h after recovery (see **(3)**) • on completion of exposure, the equipment shall be examined to verify that deterioration or corrosion (if any) is superficial in nature
13	Electrostatic discharge	IEC 61000-4-2	Contact discharge: 6 kV Air discharge: 2 kV, 4 kV, 8 kV Interval between single discharges: 1 sec. No. of pulses: 10 per polarity According to test level 3	• to simulate electrostatic discharge as may occur when persons touch the appliance • the test is to be confined to the points and surfaces that can normally be reached by the operator • performance criterion B (see **(4)**)
14	Radiated Radio Frequency	IEC 61000-4-3	Frequency range: 80 MHz to 2 GHz Modulation**: 80% AM at 1000Hz Field strength: 10V/m Frequency sweep rate: $\leq 1,5.10^{-3}$ decades/s (or 1% / 3 sec) According to test level 3	• to simulate electromagnetic fields radiated by different transmitters • the test is to be confined to the appliances exposed to direct radiation by transmitters at their place of installation • performance criterion A (see **(5)**) ** If, for tests of equipment, an input signal with a modulation frequency of 1000 Hz is necessary, a modulation frequency of 400 Hz should be chosen
15	Conducted low Frequency		A.C.: • Frequency range: rated frequency to 200th harmonic • Test voltage (rms): 10% of supply to 15th harmonic reducing to 1% at 100th harmonic and maintain this level to the 200th harmonic, min 3 V r.m.s, max. 2 W D.C.: • Frequency range: 50 Hz - 10 kHz • Test voltage (rms): 10% of supply, max. 2 W	• to simulate distortions in the power supply system generated, for instance, by electronic consumers and coupled in as harmonics • performance criterion A (see **(5)**) • see figure "Test set-up" (see **(8)**) • for keeping max. 2W, the voltage of the test signal may be lower

No.	Test	Procedure **(6)**	Test parameters	Other information
16	Conducted Radio Frequency	IEC 61000-4-6	AC, DC, I/O ports and signal/control lines Frequency range: 150 kHz - 80 MHz Amplitude: 3 V rms (see **(7)**) Modulation***: 80% AM at 1000 Hz Frequency sweep range: ≤ $1,5.10^{-3}$ decades/s (or 1% / 3sec.) According to test level 2	• to simulate electromagnetic fields coupled as high frequency into the test specimen via the connecting lines • performance criterion A (see **(5)**) *** If, for tests of equipment, an input signal with a modulation frequency of 1000 Hz is necessary, a modulation frequency of 400 Hz should be chosen
17	Electrical Fast Transients / Burst	IEC 61000-4-4	Single pulse time: 5ns (between 10% and 90% value) Single pulse width: 50 ns (50% value) Amplitude (peak): 2 kV line on power supply port/earth; 1 kV on I/O data control and communication ports (coupling clamp) Pulse period: 300 ms Burst duration: 15 ms Duration/polarity: 5 min According to test level 3	• arcs generated when actuating electrical contacts • interface effect occurring on the power supply, as well as at the external wiring of the test specimen • performance criterion B (see **(4)**)
18	Surge	IEC 61000-4-5	Test applicable to AC and DC power ports. Open-circuit voltage: • Pulse rise time: 1,2 μs (front time) • Pulse width: 50 μs (time of half value) • Amplitude (peak): 1 kV line/earth; 0,5kV line/line Short circuit current: • Pulse rise time: 8 μs (front time) • Pulse width: 20 μs (time of half value) Repetition rate: ≥ 1 pulse/min No of pulses: 5 per polarity Application: continuous According to test level 2	• to simulate interference generated, for instance, by switching "ON" or "OFF" high power inductive consumers • test procedure in accordance with figure 10 of the standard for equipment where power and signal lines are identical • performance criterion B (see **(4)**)
19	Radiated Emission	CISPR 16-2-3	• For equipment installed in the bridge and deck zone: Frequency range (MHz): / Quasi peak limits: (dBμV/m) 0,15 - 0,30 / 80- 52 0,30 - 30 / 52- 34 30 - 2000 / 54 except for: 156 - 165 / 24 • For equipment installed in the general power distribution zone: Frequency range: (MHz) / Quasi peak limits: (dBμV/m) 0,15 - 30 / 80 - 50 30 - 100 / 60 - 54 100 - 2000 / 54 except for: 156 - 165 / 24	• procedure in accordance with the standard but distance 3 m between equipment and antenna • alternatively the radiation limit at a distance of 3 m from the enclosure port over the frequency 156 MHz to 165 MHz shall be 30 dB micro-V/m peak

No.	Test	Procedure **(6)**	Test parameters	Other information
20	Conducted Emission	CISPR 16-2-1	Test applicable to AC and DC power ports • For equipment installed in the bridge and deck zone: Frequency range: / Limits: (dBμV) 10 - 150 kHz / 96 - 50 150 - 350 kHz / 60 - 50 0,35 - 30 MHz / 50 • For equipment installed in the general power distribution zone: Frequency range: / Limits: (dBμV) 10 - 150 kHz / 120 - 69 150 - 500 kHz / 79 0,50 - 30 MHz / 73	
21	Flame retardant	IEC 60092-101 or IEC 60695-11-5	Flame application: 5 times 15 s each Interval between each application: 15 s or 1 time 30 s	• the burnt out or damaged part of the specimen by not more than 60mm long • no flame, no incandescence or in the event of a flame or incandescence being present, it shall extinguish itself within 30 s of the removal of the needle flame without full combustion of the test specimen • any dripping material shall extinguish itself in such a way as not to ignite a wrapping tissue. The drip height is 200 mm ± 5 mm

(1) Equipment to be mounted in consoles, housing etc. together with other equipment are to be tested with 70°C.

(2) For equipment installed in non-weather protected locations or cold locations, test is to be carried out at –25°C.

(3) Salt mist test is to be carried out for equipment installed in weather exposed areas.

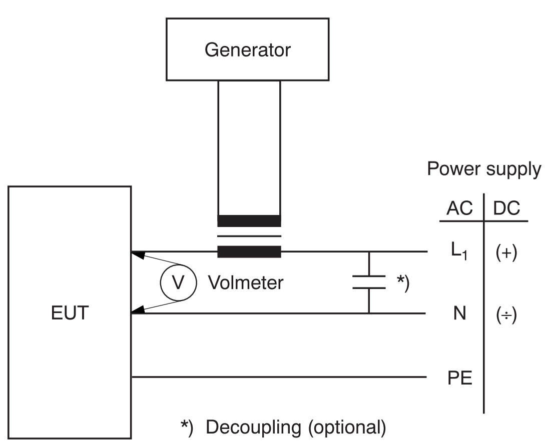
(4) Performance criterion B: (for transient phenomena): The Equipment Under Test shall continue to operate as intended after the tests. No degradation of performance or loss of function is allowed as defined in the technical specification published by the Manufacturer. During the test, degradation or loss of function or performance which is self recoverable is however allowed but no change of actual operating state or stored data is allowed.

(5) Performance criterion A (for continuous phenomena): The EUT shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed as defined in relevant equipment standard and the technical specification published by the Manufacturer.

(6) Column 3 indicates the testing procedure which is normally to be applied. However, equivalent testing procedure may be accepted by the Society provided that what is required in the other columns is fulfilled.

(7) For equipment installed on the bridge and deck zone, the test levels shall be increased to 10V rms for spot frequencies in accordance with IEC 60945 at 2,3,4,6.2, 8.2, 12.6, 16.5, 18.8, 22, 25 MHz.

(8) Figure - Test set-up for Conducted Low Frequency - Refer to IEC Publication 60945 (1996).



(9) See [2.2.2], Note 1.

CHAPTER 4

Ch 4, Sec 1, [2.5.1]

Add the following items aa) and ab) in the alphanumeric of requirement [2.5.1]:

aa) Flammable gas detection system

ab) Fixed fire extinguishing systems for protection of galley cooking equipment.

Ch 4, Sec 1, [3]

Add the following sub-articles [3.45], [3.46] and [3.47]:

3.45 Fire damper

3.45.1 *Fire damper is, for the purpose of implementing requirements of Ch 4, Sec 5, [6], a device installed in a ventilation duct, which under normal conditions remains open allowing flow in the duct, and is closed during a fire, preventing the flow in the duct to restrict the passage of fire. In using the above definition the following terms may be associated:*

a) automatic fire damper is a fire damper that closes independently in response to exposure to fire products;

b) manual fire damper is a fire damper that is intended to be opened or closed by the crew by hand at the damper itself; and

c) remotely operated fire damper is a fire damper that is closed by the crew through a control located at a distance away from the controlled damper.

3.46 Smoke damper

3.46.1 *Smoke damper is, for the purpose of implementing requirements of Ch 4, Sec 5, [6], a device installed in a ventilation duct, which under normal conditions remains open allowing flow in the duct, and is closed during a fire, preventing the flow in the duct to restrict the passage of smoke and hot gases. A smoke damper is not expected to contribute to the integrity of a fire rated division penetrated by a ventilation duct. In using the above definition the following terms may be associated:*

a) automatic smoke damper is a smoke damper that closes independently in response to exposure to smoke or hot gases;

b) manual smoke damper is a smoke damper intended to be opened or closed by the crew by hand at the damper itself; and

c) remotely operated smoke damper is a smoke damper that is closed by the crew through a control located at a distance away from the controlled damper.

3.47 Vehicle carrier

3.47.1 *Vehicle carrier means a cargo ship with multi deck ro-ro spaces designed for the carriage of empty cars and trucks as cargo.*

Ch 4, Sec 4, [2.1]

Replace requirement [2.1.2] by:

2.1.2 For ships other than passenger ships carrying more than 36 passengers, equally effective local closing arrangements means that in the case of ventilators these are to be fitted with fire dampers or smoke dampers which are to be easily closed within the control station in order to maintain the absence of smoke in the event of fire.

Ch 4, Sec 5

Replace Article 6 by the following Article 6:

6 Ventilation systems

6.1 Application

6.1.1 The provisions of [6.2] to [6.4], [6.6], and [6.7] apply to ships of all types.

The provisions of [6.5] and [6.8] apply to passenger ships carrying more than 36 passengers.

6.2 General

6.2.1 *Ventilation ducts, including single and double wall ducts, shall be of steel or equivalent material except flexible bellows of short length not exceeding 600 mm used for connecting fans to the ducting in air-conditioning rooms. Unless expressly provided otherwise in [6.2.6], any other material used in the construction of ducts, including insulation, shall also be non-combustible. However, short ducts,* *not generally exceeding 2 m in length and with a free cross-sectional area not exceeding 0.02 m², need not be of steel or equivalent material, subject to the following conditions:*

a) the ducts shall be made of non-combustible material, which may be faced internally and externally with membranes having low flame-spread characteristics and, in each case, a calorific value not exceeding 45 MJ/m² of their surface area for the thickness used;

b) the ducts are only used at the end of the ventilation device; and

c) the ducts are not situated less than 600 mm, measured along the duct, from an opening in an "A" or "B" class division, including continuous "B" class ceiling.

Note 1: The term free cross-sectional area means, even in the case of a pre-insulated duct, the area calculated on the basis of the inner dimensions of the duct itself and not the insulation.

6.2.2 *The following arrangements shall be tested in accordance with the Fire Test Procedures Code:*

a) fire dampers, including their relevant means of operation, however, the testing is not required for dampers located at the lower end of the duct in exhaust ducts for galley ranges, which must be of steel and capable of stopping the draught in the duct; and

b) duct penetrations through "A" class divisions. However, the test is not required where steel sleeves are directly joined to ventilation ducts by means of riveted or screwed connections or by welding.

6.2.3 *Fire dampers shall be easily accessible. Where they are placed behind ceilings or linings, these ceilings or linings shall be provided with an inspection hatch on which the identification number of the fire damper is marked. The fire damper identification number shall also be marked on any remote controls provided.*

6.2.4 *Ventilation ducts shall be provided with hatches for inspection and cleaning. The hatches shall be located near the fire dampers.*

6.2.5 *The main inlets and outlets of ventilation systems shall be capable of being closed from outside the spaces being ventilated. The means of closing shall be easily accessible as well as prominently and permanently marked and shall indicate the operating position of the closing device.*

6.2.6 *Combustible gaskets in flanged ventilation duct connections are not permitted within 600 mm of openings in "A" or "B" class divisions and in ducts required to be of "A" class construction.*

6.2.7 *Ventilation openings or air balance ducts between two enclosed spaces shall not be provided except as permitted by [3.2.2] and [3.3.3].*

6.3 Arrangement of ducts

6.3.1 *The ventilation systems for machinery spaces of category A, vehicle spaces, ro-ro spaces, galleys, special category spaces and cargo spaces shall, in general, be separated from each other and from the ventilation systems serving other spaces. However, the galley ventilation systems on cargo ships of less than 4,000 gross tonnage and in passenger ships carrying not more than 36 passengers need not be completely separated from other ventilation systems, but may be served by separate ducts from a ventilation unit serving other spaces. In such a case, an automatic fire damper shall be fitted in the galley ventilation duct near the ventilation unit.*

6.3.2 *Ducts provided for the ventilation of machinery spaces of category A, galleys, vehicle spaces, ro-ro spaces or special category spaces shall not pass through accommodation spaces, service spaces, or control stations unless they comply with [6.3.4].*

6.3.3 *Ducts provided for the ventilation of accommodation spaces, service spaces or control stations shall not pass through machinery spaces of category A, galleys, vehicle spaces, ro-ro spaces or special category spaces unless they comply with [6.3.4].*

6.3.4 *As permitted by [6.3.2] and [6.3.3] ducts shall be either:*

a)

1) constructed of steel having a thickness of at least 3 mm for ducts with a free cross-sectional area of less than 0.075 m², at least 4 mm for ducts with a free cross-sectional area of between 0.075 m² and 0.45 m², and at least 5 mm for ducts with a free cross-sectional area of over 0.45 m²;

2) suitably supported and stiffened;

3) fitted with automatic fire dampers close to the boundaries penetrated; and

4) insulated to "A-60" class standard from the boundaries of the spaces they serve to a point at least 5 m beyond each fire damper; or

b)

1) constructed of steel in accordance with item a) 1) and item a) 2); and

2) insulated to "A-60" class standard throughout the spaces they pass through, except for ducts that pass through spaces of category (9) or (10) as defined in [1.3.3], item b).

6.3.5 *For the purposes of [6.3.4], item a) 4) and [6.3.4], item b) 2), ducts shall be insulated over their entire cross-sectional external surface. Ducts that are outside but adjacent to the specified space, and share one or more surfaces with it, shall be considered to pass through the specified space, and shall be insulated over the surface they share with the space for a distance of 450 mm past the duct.*

6.3.6 *Where it is necessary that a ventilation duct passes through a main vertical zone division, an automatic fire damper shall be fitted adjacent to the division. The damper shall also be capable of being manually closed from each side of the division. The control location shall be readily accessible and be clearly and prominently marked. The* *duct between the division and the damper shall be constructed of steel in accordance with [6.3.4], item a) 1) and [6.3.4], item a) 2) and insulated to at least the same fire integrity as the division penetrated. The damper shall be fitted on at least one side of the division with a visible indicator showing the operating position of the damper.*

6.4 Details of fire dampers and duct penetrations

6.4.1 *Ducts passing through "A" class divisions shall meet the following requirements:*

a) where a thin plated duct with a free cross sectional area equal to, or less than, 0.02 m² passes through "A" class divisions, the opening shall be fitted with a steel sheet sleeve having a thickness of at least 3 mm and a length of at least 200 mm, divided preferably into 100 mm on each side of a bulkhead or, in the case of a deck, wholly laid on the lower side of the decks penetrated;

b) where ventilation ducts with a free cross-sectional area exceeding 0.02 m², but not more than 0.075 m², pass through "A" class divisions, the openings shall be lined with steel sheet sleeves. The ducts and sleeves shall have a thickness of at least 3 mm and a length of at least 900 mm. When passing through bulkheads, this length shall be divided preferably into 450 mm on each side of the bulkhead. These ducts, or sleeves lining such ducts, shall be provided with fire insulation. The insulation shall have at least the same fire integrity as the division through which the duct passes

Equivalent penetration protection may be provided to the satisfaction of the Society, and

c) automatic fire dampers shall be fitted in all ducts with a free cross-sectional area exceeding 0.075 m² that pass through "A" class divisions. Each damper shall be fitted close to the division penetrated and the duct between the damper and the division penetrated shall be constructed of steel in accordance with [6.3.4], item b) 1) and [6.3.4], item b) 2). The fire damper shall operate automatically, but shall also be capable of being closed manually from both sides of the division. The damper shall be fitted with a visible indicator which shows the operating position of the damper. Fire dampers are not required, however, where ducts pass through spaces surrounded by "A" class divisions, without serving those spaces, provided those ducts have the same fire integrity as the divisions which they penetrate. A duct of cross-sectional area exceeding 0.075 m² shall not be divided into smaller ducts at the penetration of an "A" class division and then recombined into the original duct once through the division to avoid installing the damper required by this provision.

6.4.2 *Ventilation ducts with a free cross-sectional area exceeding 0.02 m² passing through "B" class bulkheads shall be lined with steel sheet sleeves of 900 mm in length, divided preferably into 450 mm on each side of the bulkheads unless the duct is of steel for this length.*

6.4.3 *All fire dampers shall be capable of manual operation. The dampers shall have a direct mechanical means of release or, alternatively, be closed by electrical, hydraulic, or pneumatic operation. All dampers shall be manually operable from both sides of the division. Automatic fire dampers, including those capable of remote operation, shall have a failsafe mechanism that will close the damper in a fire even upon loss of electrical power or hydraulic or pneumatic pressure loss. Remotely operated fire dampers shall be capable of being reopened manually at the damper.*

6.5 Ventilation systems for passenger ships carrying more than 36 passengers

6.5.1 *In addition to the requirements in [6.2], [6.3] and [6.4], the ventilation system of a passenger ship carrying more than 36 passengers shall also meet the following requirements.*

6.5.2 *In general, the ventilation fans shall be so arranged that the ducts reaching the various spaces remain within a main vertical zone.*

6.5.3 *Stairway enclosures shall be served by an independent ventilation fan and duct system (exhaust and supply) which shall not serve any other spaces in the ventilation systems.*

6.5.4 *A duct, irrespective of its cross-section, serving more than one 'tween-deck accommodation space, service space or control station, shall be fitted, near the penetration of each deck of such spaces, with an automatic smoke damper that shall also be capable of being closed manually from the protected deck above the damper. Where a fan serves more than one 'tween-deck space through separate ducts within a main vertical zone, each dedicated to a single 'tween-deck space, each duct shall be provided with a manually operated smoke damper fitted close to the fan.*

6.5.5 *Vertical ducts shall, if necessary, be insulated as required by Tab 1 and Tab 2. Ducts shall be insulated as required for decks between the space they serve and the space being considered, as applicable.*

6.6 Exhaust ducts from galley ranges

6.6.1 Requirements for passenger ships carrying more than 36 passengers

a) In addition to the requirements in [6.2], [6.3] and [6.4], exhaust ducts from galley ranges shall be constructed in accordance with [6.3.4], item b) 1) and [6.3.4], item b) 2) and insulated to "A-60" class standard throughout accommodation spaces, service spaces, or control stations they pass through. They shall also be fitted with:

1) a grease trap readily removable for cleaning unless an alternative approved grease removal system is fitted;

2) a fire damper located in the lower end of the duct at the junction between the duct and the galley range hood which is automatically and remotely operated and, in addition, a remotely operated fire damper located in the upper end of the duct close to the outlet of the duct ;

3) a fixed means for extinguishing a fire within the duct;

4) *remote-control arrangements for shutting off the exhaust fans and supply fans, for operating the fire dampers mentioned in item a) 2) and for operating the fire-extinguishing system, which shall be placed in a position outside the galley close to the entrance to the galley. Where a multi-branch system is installed, a remote means located with the above controls shall be provided to close all branches exhausting through the same main duct before an extinguishing medium is released into the system; and*

5) *suitably located hatches for inspection and cleaning, including one provided close to the exhaust fan and one fitted in the lower end where grease accumulates.*

The requirements given in item a) 1) to item a) 5) apply to all exhaust ducts from galley ranges in which grease or fat is likely to accumulate from galley ranges.

b) *Exhaust ducts from ranges for cooking equipment installed on open decks shall conform to item a), as applicable, when passing through accommodation spaces or spaces containing combustible materials.*

6.6.2 Requirements for cargo ships and passenger ships carrying not more than 36 passengers

When passing through accommodation spaces or spaces containing combustible materials, the exhaust ducts from galley ranges shall be constructed in accordance with [6.3.4], item a) 1) and [6.3.4], item a) 2). Each exhaust duct shall be fitted with:

a) *a grease trap readily removable for cleaning;*

b) *an automatically and remotely operated fire damper located in the lower end of the duct at the junction between the duct and the galley range hood and, in addition, a remotely operated fire damper in the upper end of the duct close to the outlet of the duct;*

c) *arrangements, operable from within the galley, for shutting off the exhaust and supply fans; and*

d) *fixed means for extinguishing a fire within the duct.*

Pt C, Ch 4, Sec 6, [1.2]

Replace requirement [1.2.3] as follow:

1.2.3 Diameter of fire mains

The diameter of the fire main and water service pipes shall be sufficient for the effective distribution of the maximum required discharge from two fire pumps operating simultaneously, except that in the case of cargo ships other than those included in [6.3], the diameter need only be sufficient for the discharge of 140 m^3/hour.

6.7 Ventilation rooms serving machinery spaces of category A containing internal combustion machinery

6.7.1 *Where a ventilation room serves only such an adjacent machinery space and there is no fire division between the ventilation room and the machinery space, the means for closing the ventilation duct or ducts serving the machinery space shall be located outside of the ventilation room and machinery space.*

6.7.2 *Where a ventilation room serves such a machinery space as well as other spaces and is separated from the machinery space by a "A-0" class division, including penetrations, the means for closing the ventilation duct or ducts for the machinery space can be located in the ventilation room.*

6.8 Ventilation systems for laundries in passenger ships carrying more than 36 passengers

6.8.1 *Exhaust ducts from laundries and drying rooms of category (13) spaces as defined in [1.3.3], item b) shall be fitted with:*

a) *filters readily removable for cleaning purposes;*

b) *a fire damper located in the lower end of the duct which is automatically and remotely operated;*

c) *remote-control arrangements for shutting off the exhaust fans and supply fans from within the space and for operating the fire damper mentioned in item b); and*

d) *suitably located hatches for inspection and cleaning.*

Ch 4, Sec 6, [1.3.4], item a)

Replace item a) 2) by:

2) *pumps in cargo ships, other than any emergency pump: the quantity of water is not less than four thirds of the quantity required in Ch 1, Sec 10 to be dealt with by each of the independent bilge pumps in a passenger ship of the same dimension when employed in bilge pumping, provided that in no cargo ship other than those included in [6.3], need the total required capacity of the fire pumps exceed 180 m^3/hour.*

Ch 4, Sec 6, [4]

Replace the Title of Sub-article [4.3] as follow:

4.3 Machinery spaces of category A containing internal combustion machinery

Ch 4, Sec 6, [6]

Add the following sub-article [6.3]:

6.3 Firefighting for ships designed to carry containers on or above the weather deck

6.3.1 *Ships shall carry, in addition to the equipment and arrangements required by article [1], at least one water mist lance.*

The water mist lance shall consist of a tube with a piercing nozzle which is capable of penetrating a container wall and producing water mist inside a confined space (container, etc.) when connected to the fire main.

6.3.2 *Ships designed to carry five or more tiers of containers on or above the weather deck shall carry, in addition to the requirements of [6.3.1], mobile water monitors as follows, and comply with item a) to d):*

- *ships with breadth less than 30 m: at least two mobile water monitors; or*
- *ships with breadth of 30 m or more: at least four mobile water monitors.*

a) *The mobile water monitors, all necessary hoses, fittings and required fixing hardware shall be kept ready for use in a location outside the cargo space area not likely to be cut-off in the event of a fire in the cargo spaces.*

b) *A sufficient number of fire hydrants shall be provided such that:*

   1) *all provided mobile water monitors can be operated simultaneously for creating effective water barriers forward and aft of each container bay;*

   2) *the two jets of water required by item a) of [1.2.5] can be supplied at the pressure required by [1.2.6]; and*

   3) *each of the required mobile water monitors can be supplied by separate hydrants at the pressure necessary to reach the top tier of containers on deck.*

c) *The mobile water monitors may be supplied by the fire main, provided the capacity of fire pumps and fire main diameter are adequate to simultaneously operate the mobile water monitors and two jets of water from fire hoses at therequired pressure values. If carrying dangerous goods, the capacity of fire pumps and fire main diameter shall also comply with Ch 4, Sec 11, [2.2.5], as far as applicable to on-deck cargo areas.*

d) *The operational performance of each mobile water monitor shall be tested during initial survey on board the ship to the satisfaction of the Society. The test shall verify that:*

   1) *the mobile water monitor can be securely fixed to the ship structure ensuring safe and effective operation; and*

   2) *the mobile water monitor jet reaches the top tier of containers with all required monitors and water jets from fire hoses operated simultaneously.*

Ch 4, Sec 8, [2.3.2]

Add following items e) and f) at the end of the alphanumeric list in requirement [2.3.2]:

e) *Inclined ladders and stairways*

All inclined ladders/stairways fitted to comply with a) with open treads in machinery spaces being part of or providing access to escape routes but not located within a protected enclosure shall be made of steel. Such ladders/stairways shall be fitted with steel shields attached to their undersides, such as to provide escaping personnel protection against heat and flame from beneath.

f) *Escape from main workshops within machinery spaces*

Two means of escape shall be provided from the main workshop within a machinery space. At least one of these escape routes shall provide a continuous fire shelter to a safe position outside the machinery space.

Ch 4, Sec 8, [2.3.3]

Add the following items d) e) f) and g) at the end of the alphanumeric list in requirement [2.3.3]:

d) With regard to application of items b) and c), the following applies:

- Steering gear spaces which do not contain the emergency steering position need only have one means of escape.
- Steering gear spaces containing the emergency steering position can have one means of escape provided it leads directly onto the open deck. Otherwise, two means of escape are to be provided but they do not need to lead directly onto the open deck.
- Escape routes that pass only through stairways and/or corridors that have fire integrity protection equivalent to steering gear spaces are considered as providing a "direct access to the open deck".

e) *Inclined ladders and stairways*

All inclined ladders/stairways fitted to comply with a) with open treads in machinery spaces being part of or providing access to escape routes but not located within a protected enclosure shall be made of steel. Such ladders/stairways shall be fitted with steel shields attached to their undersides, such as to provide escaping personnel protection against heat and flame from beneath.

f) *Escape from machinery control rooms in machinery spaces of category "A"*

Two means of escape shall be provided from the machinery control room located within a machinery space. At least one of these escape routes shall provide a continuous fire shelter to a safe position outside the machinery space.

g) *Escape from main workshops in machinery spaces of category "A"*

Two means of escape shall be provided from the main workshop within a machinery space. At least one of these escape routes shall provide a continuous fire shelter to a safe position outside the machinery space.

Ch 4, Sec 8, [2.5.1]

Add the following two paragraphs at the end of requirement [2.5.1]:

Ro-ro spaces should be fitted with at least two means of escape, one located at the fore end and the other at the aft end of the space, from which access is provided to the lifeboat and liferaft embarkation decks. One of the means of escape should be a stairway, the second escape may be a trunk or a stairway.

The fore and aft ends of the ro-ro space are considered as the areas being within the distance equal to the breadth of the ro-ro space, measured at its widest point, from its forward most and aftmost point.

Ch 4, Sec 12, [2.1.4]

Replace item b) in the alphanumeric list of requirement [2.1.4] by:

b) *Ventilation ducts, including dampers, within a common horizontal zone shall be made of steel. In passenger ships, ventilation ducts that pass through other horizontal zones or machinery spaces shall be A-60 class steel ducts constructed in accordance with* (new) Ch 4, Sec 5, [6.3.4], items a) and b).

Ch 4, Sec 12

Add the following article [6]:

6 Vehicle carriers carrying motor vehicles with compressed hydrogen or natural gas in their tanks for their own propulsion

6.1 Spaces intended for carriage of motor vehicles with compressed natural gas in their tanks

6.1.1 Electrical equipment and wiring

All electrical equipment and wiring shall be of a certified safe type for use in an explosive methane and air mixture

Note 1: Refer to the recommendations of the International Electrotechnical Commission, in particular, publication IEC 60079.

6.1.2 Ventilation arrangement

a) Electrical equipment and wiring, if installed in any ventilation duct, shall be of a certified safe type for use in explosive methane and air mixtures.

b) The fans shall be such as to avoid the possibility of ignition of methane and air mixtures. Suitable wire mesh guards shall be fitted over inlet and outlet ventilation openings.

6.1.3 Other ignition sources

Other equipment which may constitute a source of ignition of methane and air mixtures shall not be permitted.

6.2 Spaces intended for carriage of motor vehicles with compressed hydrogen in their tanks

6.2.1 Electrical equipment and wiring

All electrical equipment and wiring shall be of a certified safe type for use in an explosive hydrogen and air mixture

Note 1: Refer to the recommendations of the International Electrotechnical Commission, in particular, publication IEC 60079.

6.2.2 Ventilation arrangement

a) Electrical equipment and wiring, if installed in any ventilation duct, shall be of a certified safe type for use in explosive hydrogen and air mixtures and the outlet from any exhaust duct shall be sited in a safe position, having regard to other possible sources of ignition.

b) The fans shall be designed such as to avoid the possibility of ignition of hydrogen and air mixtures. Suitable wire mesh guards shall be fitted over inlet and outlet ventilation openings.

6.2.3 Other ignition sources

Other equipment which may constitute a source of ignition of hydrogen and air mixtures shall not be permitted.

6.3 Detection

6.3.1 *When a vehicle carrier carries as cargo one or more motor vehicles with either compressed hydrogen or compressed natural gas in their tanks for their own propulsion, at least two portable gas detectors shall be provided. Such detectors shall be suitable for the detection of the gas fuel and be of a certified safe type for use in the explosive gas and air mixture.*

Ch 4, Sec 14, [4.1.1]

Replace the second paragraph in item c) 2) of the alphanumeric list in requirement [4.1.1] by:

Conventional cargo spaces need not comply with the above. However, ro-ro cargo spaces, holds in container ships equipped for integrated reefer containers and other spaces where personnel can be expected to enter and where the access is therefore facilitated by doors or manway hatches should comply with the above requirement.

Ch 4, Sec 14, [4.1.2]

Add the following Note 2 at the end of item b) of the alphanumeric list in requirement [4.1.2]:

Note 2: The controls requirements detailed in item b) apply to the spaces identified in [4.1.1], item c) 2) to be provided with a pre-discharge alarm.

Ch 4, Sec 14, [5.1.2]

Replace item n) of the alphanumeric list in requirement [5.1.2] by:

n) Nominal filling rate is the ratio of nominal foam production to the area, i.e. expressed in m/min.

Ch 4, Sec 14, [5.2.2]

Add the following four paragraphs at the end of item a) 2) in the alphanumeric list of requirement [5.2.2]:

Where such a machinery space includes a casing (e.g. an engine casing in a machinery space of category A containing internal combustion machinery, and/or a boiler), the volume of such casing, above the level up to which foam shall be filled to protect the highest position of the fire risk objects within the machinery space, need not be included in the volume of the protected space.

The level up to which foam shall be filled to protect the highest positioned fire risk objects within the machinery space shall not be less than whichever is higher between 1 m above the highest point of any such object; and the lowest part of the casing.

Where such a machinery space does not include a casing, the volume of the largest protected space shall be that of the space in its entirety, irrespective of the location of any fire risk object therein.

Fire risk objects include, but may not be limited to, those listed in Ch 4, Sec 1, [3.24.1], and those defined in Ch 4, Sec 1, [3.27.1], although not referred to in those requirements, they may also include items having a similar fire risk such as exhaust gas boilers or oil fuel tanks.

Ch 4, Sec 14, [8.2.1] (Amendments July 2015)

Insert the following Note 1 at the end of item b) 4) of the alphanumeric list in requirement [8.2.1]:

Note 1: The ventilation fans and the fire dampers serving a machinery room equipped with internal combustion engines taking their combustion air directly inside the room are not to be automatically stopped or closed in case of fire detection, in order to prevent depressurization of the room.

Ch 4, Sec 14, [8.2.5]

Add the following two paragraphs at the end of item a) 1) in the alphanumeric list of requirement [8.2.5]:

The alarm sounder system utilized by the fixed fire detection and fire alarm system should be powered from no less than two sources of power, one of which should be an emergency source of power.

For ships provided with a transitional source of emergency electrical power, as required by:

- Pt D, Ch 11, Sec 5, [2],
- Ch 2, Sec 3, [2], and
- Ch 2, Sec 3, [3],

the alarm sounder system should also be powered from this power source.

Replace item a) 3) in the alphanumeric list of requirement [8.2.5] as follow:

3) *In passenger ships, an indicating unit that is capable of individually identifying each detector that has been activated or manually operated call point that has operated shall be located on the navigation bridge. In cargo ships, an indicating unit shall be located on the navigation bridge if the control panel is located in the fire control station. In ships with a cargo control room, an additional indicating unit shall be located in the cargo control room. In cargo ships and on passenger cabin balconies, indicating units shall, as a minimum, denote the section in which a detector has activated or manually operated call point has been operated.*

A space in which a cargo control console is installed, but does not serve as a dedicated cargo control room (e.g. ship's office, machinery control room), should be regarded as a cargo control room for the purposes of this requirement and therefore be provided with an additional indicating unit.

Ch 4, Sec 14, [9.1.4]

Add the following paragraph at the end of item a) 2) in the alphanumeric list of requirement [9.1.4]:

the control panel can be located in the CO_2 room provided that an indicating unit is located on the navigation bridge. Indicating unit has the same meaning as repeater panel and observation of smoke should be made either by electrical means or by visual on repeater panel

Ch 4, Sec 14, [11.1.2]

Add the following paragraph at the end of item a) 1) in the alphanumeric list of requirement [11.1.2]:

On board cargo ships designed to carry five or more tiers of containers on or above the weather deck:

- the total capacity of the main fire pumps need not exceed 180 m^3/h in cases where the mobile water monitors are supplied by separate pumps and piping system
- the total capacity of the emergency fire pump need not exceed 72 m^3/h.

Ch 4, Sec 14

Add the following Article 13:

13 Inert gas systems

13.1 Definitions

13.1.1 *For the purposes of this Article:*

a) Cargo tanks means those cargo tanks, including slop tanks, which carry cargoes, or cargo residues, having a flashpoint not exceeding 60°C.

b) Inert gas system includes inert gas systems using flue gas, inert gas generators, and nitrogen generators and means the inert gas plant and inert gas distribution together with means for preventing backflow of cargo gases to machinery spaces, fixed and portable measuring instruments and control devices.

c) Gas-safe space is a space in which the entry of gases would produce hazards with regard to flammability or toxicity.

d) Gas-free is a condition in a tank where the content of hydrocarbon or other flammable vapour is less than 1% of the lower flammable limit (LFL), the oxygen content is at least 21%, and no toxic gases are present.

Note 1: Refer to the Revised recommendations for entering enclosed spaces aboard ships (IMO resolution A.1050(27)).

13.2 Requirements for all systems

13.2.1 General

a) The inert gas systems shall be designed, constructed and tested to the satisfaction of the Society. It shall be designed to be capable of rendering and maintaining the atmosphere of the relevant cargo tanks non-flammable.

Note 1: Refer to the Revised standards for the design, testing and locating of devices to prevent the passage of flame into cargo tanks in tankers (MSC/Circ.677, as amended by MSC/Circ.1009 and MSC.1/Circ.1324) and the Revised factors to be taken into consideration when designing cargo tank venting and gas-freeing arrangements (MSC/Circ.731).

b) The system shall be capable of:

1) inerting empty cargo tanks and maintaining the atmosphere in any part of the tank with an oxygen content not exceeding 8% by volume and at a positive pressure in port and at sea except when it is necessary for such a tank to be gas-free;

2) eliminating the need for air to enter a tank during normal operations except when it is necessary for such a tank to be gas-free;

3) purging empty cargo tanks of hydrocarbon or other flammable vapours, so that subsequent gas-freeing operations will at no time create a flammable atmosphere within the tank;

4) delivering inert gas to the cargo tanks at a rate of at least 125% of the maximum rate of discharge capacity of the ship expressed as a volume. For chemical tankers and chemical/product tankers, the Society may accept inert gas systems having a lower delivery capacity provided that the maximum rate of discharge of cargoes from cargo tanks being protected by the system is restricted to not more than 80% of the inert gas capacity; and

5) delivering inert gas with an oxygen content of not more than 5% by volume to the cargo tanks at any required rate of flow.

c) Materials used in inert gas systems shall be suitable for their intended purpose. In particular, those components which may be subjected to corrosive action of the gases and/or liquids are to be either constructed of corrosion-resistant material or lined with rubber, glass fibre epoxy resin or other equivalent coating material.

d) The inert gas supply may be:

1) treated flue gas from main or auxiliary boilers, or

2) gas from an oil or gas-fired gas generator, or

3) gas from nitrogen generators.

The Society may accept systems using inert gases from one or more separate gas generators or other sources or any combination thereof, provided that an equivalent level of safety is achieved. Such systems shall, as far as practicable, comply with the requirements of this article. Systems using stored carbon dioxide shall not be permitted unless the Administration is satisfied that the risk of ignition from generation of static electricity by the system itself is minimized.

13.2.2 Safety measures

a) The inert gas system shall be so designed that the maximum pressure which it can exert on any cargo tank will not exceed the test pressure of any cargo tank.

b) Automatic shutdown of the inert gas system and its components parts shall be arranged on predetermined limits being reached, taking into account the provisions of [13.2.4], [13.3.3] and [13.4.3].

c) Suitable shutoff arrangements shall be provided on the discharge outlet of each generator plant.

d) The system shall be designed to ensure that if the oxygen content exceeds 5% by volume, the inert gas shall be automatically vented to atmosphere.

e) Arrangements shall be provided to enable the functioning of the inert gas plant to be stabilized before commencing cargo discharge. If blowers are to be used for gas-freeing, their air inlets shall be provided with blanking arrangements.

f) Where a double block and bleed valve is installed, the system shall ensure upon of loss of power, the block valves are automatically closed and the bleed valve is automatically open.

13.2.3 System components

a) Non-return devices

1) At least two non-return devices shall be fitted in order to prevent the return of vapour and liquid to the inert gas plant, or to any gas-safe spaces.

2) The first non-return device shall be a deck seal of the wet, semi-wet, or dry type or a double-block and bleed arrangement. Two shut-off valves in series with a venting valve in between, may be accepted provided:

- *the operation of the valve is automatically executed. Signal(s) for opening/closing is (are) to be taken from the process directly, e.g. inert gas flow or differential pressure; and*
- *alarm for faulty operation of the valves is provided, e.g. the operation status of "blower stop" and "supply valve(s) open" is an alarm condition.*

3) The second non-return device shall be a non-return valve or equivalent capable of preventing the return of vapours and liquids and fitted between the deck water seal (or equivalent device) and the first connection from the inert gas main to a cargo tank. It shall be provided with positive means of closure. As an alternative to positive means of closure, an additional valve having such means of closure may be provided between the non-return valve and the first connection to the cargo tanks to isolate the deck water seal, or equivalent device, from the inert gas main to the cargo tanks.

4) A water seal, if fitted, shall be capable of being supplied by two separate pumps, each of which shall be capable of maintaining an adequate supply at all times. The audible and visual alarm on the low level of water in the water seal shall operate at all times.

5) The arrangement of the water seal, or equivalent devices, and its associated fittings shall be such that it will prevent backflow of vapours and liquids and will ensure the proper functioning of the seal under operating conditions.

6) Provision shall be made to ensure that the water seal is protected against freezing, in such a way that the integrity of seal is not impaired by overheating.

7) A water loop or other approved arrangement shall also be fitted to each associated water supply and drain pipe and each venting or pressure-sensing pipe leading to gas-safe spaces. Means shall be provided to prevent such loops from being emptied by vacuum.

8) Any water seal, or equivalent device, and loop arrangements shall be capable of preventing return of vapours and liquids to an inert gas plant at a pressure equal to the test pressure of the cargo tanks.

9) The non-return devices shall be located in the cargo area on deck.

b) Inert gas lines

1) The inert gas main may be divided into two or more branches forward of the non-return devices required by [13.2.3], item a).

2) The inert gas main shall be fitted with branch piping leading to the cargo tank. Branch piping for inert gas shall be fitted with either stop valves or equivalent means of control for isolating each tank. Where stop valves are fitted, they shall be provided with locking arrangements. The control system shall provide unambiguous information of the operational status of such valves to at least the control panel required in [13.2.4].

3) Each cargo tank not being inerted shall be capable of being separated from the inert gas main by:

- *removing spool-pieces, valves or other pipe sections, and blanking the pipe ends; or*
- *arrangement of two spectacle flanges in series with provisions for detecting leakage into the pipe between the two spectacle flanges; or*
- *equivalent arrangements to the satisfaction of the Society, providing at least the same level of protection.*

4) Means shall be provided to protect cargo tanks against the effect of overpressure or vacuum caused by thermal variations and/or cargo operations when the cargo tanks are isolated from the inert gas mains.

5) Piping systems shall be so designed as to prevent the accumulation of cargo or water in the pipelines under all normal conditions.

6) Arrangements shall be provided to enable the inert gas main to be connected to an external supply of inert gas. The arrangements shall consist of a 250 mm nominal pipe size bolted flange, isolated from the inert gas main by a valve and located forward of the non-return valve. The design of the flange should *conform to the appropriate class in the standards adopted for the design of other external connections in the ship's cargo piping system.*

7) If a connection is fitted between the inert gas main and the cargo piping system, arrangements shall be made to ensure an effective isolation having regard to the large pressure difference which may exist between the systems. This shall consist of two shut-off valves with an arrangement to vent the space between the valves in a safe manner or an arrangement consisting of a spool-piece with associated blanks.

8) The valve separating the inert gas main from the cargo main and which is on the cargo main side shall be a non-return valve with a positive means of closure.

9) Inert gas piping systems shall not pass through accommodation, service and control station spaces.

10) In combination carriers, the arrangement to isolate the slop tanks containing oil or oil residues from other tanks shall consist of blank flanges which will remain in position at all times when cargoes other than oil are being carried except as provided for in the relevant section of the guidelines developed by the Organization.

Note 1: Refer to the Revised Guidelines for inert gas systems (MSC/Circ.353), as amended by MSC/Circ.387.

13.2.4 Indicators and alarms

a) The operation status of the inert gas system shall be indicated in a control panel.

b) Instrumentation shall be fitted for continuously indicating and permanently recording, when inert gas is being supplied:

1) the pressure of the inert gas mains forward of the non-return devices; and

2) the oxygen content of the inert gas.

c) The indicating and recording devices shall be placed in the cargo control room where provided. But where no cargo control room is provided, they shall be placed in a position easily accessible to the officer in charge of cargo operations.

d) In addition, meters shall be fitted:

1) in the navigating bridge to indicate at all times the pressure referred to in item b) 1) and the pressure in the slop tanks of combination carriers, whenever those tanks are isolated from the inert gas main; and

2) in the machinery control room or in the machinery space to indicate the oxygen content referred to in item b) 2).

e) Audible and visual alarms

1) Audible and visual alarms shall be provided, based on the system designed, to indicate:

- *oxygen content in excess of 5% by volume (see also item e) 2));*
- *failure of the power supply to the indicating devices as referred to in item b);*
- *gas pressure less than 100 mm water gauge. The alarm arrangement shall be such as to ensure that the pressure in slop tanks in combination carriers can be monitored at all times (see also item e) 2));*
- *high-gas pressure; and*
- *failure of the power supply to the automatic control system (see also item e) 2)).*

2) The alarms required in item e) 1) for:

- *oxygen content*
- *gas pressure less than 100 mm water gauge, and*
- *failure of the power supply to the automatic control system,*

shall be fitted in the machinery space and cargo control room, where provided, but in each case in such a position that they are immediately received by responsible members of the crew.

3) An audible alarm system independent of that required in item e) 1) for gas pressure less than 100 mm water gauge, or automatic shutdown of cargo pumps shall be provided to operate on predetermined limits of low pressure in the inert gas main being reached.

4) Two oxygen sensors shall be positioned at appropriate locations in the space or spaces containing the inert gas system. If the oxygen level falls below 19%, these sensors shall trigger alarms, which shall be both visible and audible inside and outside the space or spaces and shall be placed in such a position that they are immediately received by responsible members of the crew.

13.2.5 Instruction manuals

Detailed instruction manuals shall be provided on board, covering the operations, safety and maintenance requirements and occupational health hazards relevant to the inert gas system and its application to the cargo tank system.

Note 1: Refer to the Revised Guidelines for inert gas systems (MSC/Circ.353), as amended by MSC/Circ.387.

The manuals shall include guidance on procedures to be followed in the event of a fault or failure of the inert gas system.

13.3 Requirements for flue gas and inert gas generator systems

13.3.1 Application

In addition to the provisions in [13.2], for inert gas systems using flue gas or inert gas generators, the provisions of this sub-article shall apply.

13.3.2 System requirements

a) Inert gas generators

1) Two fuel oil pumps shall be fitted to the inert gas generator. Suitable fuel in sufficient quantity shall be provided for the inert gas generators.

2) The inert gas generators shall be located outside the cargo tank area. Spaces containing inert gas generators shall have no direct access to accommodation service or control station spaces, but may be located in machinery spaces. If they are not located in machinery spaces, such a compartment shall be separated by a gastight steel bulkhead and/or deck from accommodation, service and control station spaces. Adequate positive-pressure-type mechanical ventilation shall be provided for such a compartment.

b) Gas regulating valves

1) A gas regulating valve shall be fitted in the inert gas main. This valve shall be automatically controlled to close, as required in [13.2.2], item b). It shall also be capable of automatically regulating the flow of inert gas to the cargo tanks unless means are provided to automatically control the inert gas flow rate.

2) The gas regulating valve shall be located at the forward bulkhead of the forward most gas-safe space through which the inert gas main passes.

c) Cooling and scrubbing arrangement

1) Means shall be fitted which will effectively cool the volume of gas specified in [13.2.1], item b) and remove solids and sulphur combustion products. The cooling water arrangements shall be such that an adequate supply of water will always be available without interfering with any essential services on the ship. Provision shall also be made for an alternative supply of cooling water.

2) Filters or equivalent devices shall be fitted to minimize the amount of water carried over to the inert gas blowers.

d) Blowers

1) At least two inert gas blowers shall be fitted and be capable of delivering to the cargo tanks at least the volume of gas required by [13.2.1], item b). For systems fitted with inert gas generators the Society may permit only one blower if that system is capable of delivering the total volume of gas required by [13.2.1], item b) to the cargo tanks, provided that sufficient spares for the blower and its prime mover are carried on board to enable any failure of the blower and its prime mover to be rectified by the ship's crew.

2) Where inert gas generators are served by positive displacement blowers, a pressure relief device shall be provided to prevent excess pressure being developed on the discharge side of the blower.

3) When two blowers are provided, the total required capacity of the inert gas system shall be divided evenly between the two and in no case is one blower to have a capacity less than 1/3 of the total required.

e) Inert gas isolating valves

For systems using flue gas, flue gas isolating valves shall be fitted in the inert gas mains between the boiler uptakes and the flue gas scrubber. These valves shall be provided with indicators to show whether they are open or shut, and precautions shall be taken to maintain them gastight and keep the seatings clear of soot. Arrangements shall be made to ensure that boiler soot blowers cannot be operated when the corresponding flue gas valve is open.

f) Prevention of flue gas leakage

1) Special consideration shall be given to the design and location of scrubber and blowers with relevant piping and fittings in order to prevent flue gas leakages into enclosed spaces.

2) To permit safe maintenance, an additional water seal or other effective means of preventing flue gas leakage shall be fitted between the flue gas isolating valves and scrubber or incorporated in the gas entry to the scrubber.

13.3.3 Indicators and alarms

a) In addition to the requirements in [13.2.4], item b), means shall be provided for continuously indicating the temperature of the inert gas at the discharge side of the system, whenever it is operating.

b) In addition to the requirements [13.2.4], item e), audible and visual alarms shall be provided to indicate:

- *insufficient fuel oil supply to the oil-fired inert gas generator;*
- *failure of the power supply to the generator;*
- *low water pressure or low water flow rate to the cooling and scrubbing arrangement;*
- *high water level in the cooling and scrubbing arrangement;*
- *high gas temperature;*
- *failure of the inert gas blowers; and*
- *low water level in the water seal.*

13.4 Requirements for nitrogen generator systems

13.4.1 Application

In addition to the provisions in [13.2], for inert gas systems using nitrogen generators, the provisions of [13.4.2] and [13.4.3] shall apply.

13.4.2 System requirements

a) The system shall be provided with one or more compressors to generate enough positive pressure to be capable of delivering the total volume of gas required by [13.2.1], item b).

b) A feed air treatment system shall be fitted to remove free water, particles and traces of oil from the compressed air.

c) The air compressor and nitrogen generator may be installed in the engine-room or in a separate compartment. A separate compartment and any installed equipment shall be treated as an "Other machinery space" with respect to fire protection. Where a separate compartment is provided for the nitrogen generator, the compartment shall be fitted with an independent mechanical extraction ventilation system providing six air changes per hour. The compartment is to have no direct access to accommodation spaces, service spaces and control stations.

d) Where a nitrogen receiver or a buffer tank is installed, it may be installed in a dedicated compartment, in a separate compartment containing the air compressor and the generator, in the engine room, or in the cargo area. Where the nitrogen receiver or a buffer tank is installed in an enclosed space, the access shall be arranged only from the open deck and the access door shall open outwards. Adequate, independent mechanical ventilation, of the extraction type, shall be provided for such a compartment.

13.4.3 Indicators and alarms

a) In addition to the requirements in [13.2.4], item b), instrumentation is to be provided for continuously indicating the temperature and pressure of air at the suction side of the nitrogen generator.

b) In addition to the requirements in [13.2.4], item e), audible and visual alarms shall be provided to include:

- *failure of the electric heater, if fitted;*
- *low feed-air pressure or flow from the compressor;*
- *high-air temperature; and*
- *high condensate level at automatic drain of water separator.*

Amendments to PART D

Ch 1, Sec 1, Table 1 (Amendments January 2015)

Replace the row "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Greater than or equal to 500 GT	Less than 500 GT
Hull	L ≥ 65 or 90 m **(1)**	• Part B • Ch 1, Sec 2	• Part B • Ch 1, Sec 2
	L < 65 or 90 m **(1)**	• NR600	• NR600

Ch 1, Sec 2, [5]

Delete the (new) sub-article [5.2] and (new) Table 1 (from Amendments January 2015). (Amendments July 2015)

Add the following sub-article [5.3]: (Amendments January 2015)

5.3 Freeboard deck

5.3.1 Flooding

The net thickness of plating and the net scantlings of ordinary stiffeners of freeboard deck are to be determined in accordance with the applicable requirements of Pt B, Ch 7, Sec 1 and Pt B, Ch 7, Sec 2, considering the flooding pressure defined in Pt B, Ch 5, Sec 6, [9.1.1].

Ch 2, Sec 1, Table 1 (Amendments January 2015)

Replace the row "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Greater than or equal to 500 GT	Less than 500 GT
Hull	L ≥ 65 m	• Part B • Ch 2, Sec 2	• Part B • Ch 2, Sec 2
	L < 65 m	• NR600	• NR600

Ch 2, Sec 2, Table 4 (Amendments January 2015)

Replace N by N_C in Note 1 of Table 4.

Ch 2, Sec 2, [7.2.2] (Amendments July 2015)

Replace the formula of I_{YR} in requirement [7.2.2] by:

$$I_{YR} = \frac{3nZ'_R L 10^{-2}}{n_1 k}$$

Ch 2, Sec 2, [8.2.2] (Amendments July 2015)

Replace "fine mesh" by "standard mesh" in requirement [8.2.2].

Ch 2, Sec 2, [8.4.1] (Amendments July 2015)

Replace "very fine mesh" by "fine mesh" in the two first paragraphs of requirement [8.4.1].

Ch 2, Sec 2, [8.4] (Amendments July 2015)

Replace requirement [8.4.2] by:

8.4.2 Fine mesh model

Fine mesh models are to be built in accordance with Pt B, Ch 7, App 1, [3.4.4].

Ch 2, Sec 2, [8.4.3] and [8.4.4] (Amendments July 2015)

Replace "very fine mesh" by "fine mesh" in the first paragraph of requirements [8.4.3] and [8.4.4].

Ch 2, Sec 2, [9.4] (Amendments July 2015)

Insert the following requirement [9.4.7]:

9.4.7 Impact of hydro-elastic effects on damage

For ships having a length from 200 m to 300 m, the damage is to be corrected using the following partial safety factor:

$$\alpha_{HE} = 0,5 + \frac{L}{400}$$

In case the ship is granted with a notation **WhiSp**, α_{HE} is to be taken equal to 1,00.

Ch 2, Sec 2, Table 10 (Amendments January 2015)

Replace the value of K for Curve 1 and $N \leq 10^7$ by $5,802 \cdot 10^{12}$.

Ch 3, Sec 1, Table 1 (Amendments January 2015)

Replace the rows "Ship arrangement" and "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Greater than or equal to 500 GT	Less than 500 GT
Ship arrangement	L ≥ 65 or 90 m **(1)**	• Part B • Ch 3, Sec 2	• NR566 • Ch 3, Sec 2
	L < 65 or 90 m **(1)**	• NR600	• NR566 • Ch 3, Sec 2
Hull	L ≥ 65 or 90 m **(1)**	• Part B • Ch 3, Sec 2	• Part B • Ch 3, Sec 2
	L < 65 or 90 m **(1)**	• NR600	• NR600

Ch 3, Sec 2, [4.1.1] (Amendments January 2015)

Delete "or NR600, Chapter 4, as applicable" in the second paragraph of requirement [4.1.1].

Ch 3, Sec 3, [2] (Amendments July 2015)

Add the following sub-article [2.6]:

2.6 Lighting system

2.6.1 Permanently fixed adequate lighting is to be provided to give a sufficient level of illumination in passage ways between pens and access routes between or from those parts.

2.6.2 An emergency permanently fixed lighting system is to be provided in case of failure of the main electrical system required in [2.6.1]. This lighting system is to comply with the requirements in Part C, Chapter 2 for emergency lighting.

2.6.3 In addition to those required in [2.6.1], fixed or portable lightings are to be provided to give a sufficient level of illumination so that livestock can be inspected in each pen.

Ch 3, Sec 4, [2.2.2] (Amendments July 2015)

Replace reference to "Ch 3, Sec 5" by (new) "Ch 3, Sec 3, [2.6]".

Ch 4, Sec 1 (Amendments July 2015)

Replace Table 1 by:

Table 1 : Applicable requirements

Item		Ships having the additional service feature **CSR**	Ships not having the additional service feature **CSR**	
			Greater than or equal to 500 GT	Less than 500 GT
Ship arrangement	L ≥ 90	• NR606 • Ch 4, Sec 2, [3]	• Part B • Ch 4, Sec 2	• NR566 • Ch 4, Sec 2
	65 ≤ L < 90	N.A.	• Part B • Ch 4, Sec 2	• NR566 • Ch 4, Sec 2
	L < 65	N.A.	• NR600	• NR566 • Ch 4, Sec 2
Hull	L ≥ 90	• NR606	• Part B • Ch 4, Sec 3 • Ch 4, Sec 4 **(1)**	• Part B • Ch 4, Sec 3 • Ch 4, Sec 4 **(1)**
	L ≥ 65	N.A.	• Part B • Ch 4, Sec 3 • Ch 4, Sec 4 **(1)**	• Part B • Ch 4, Sec 3 • Ch 4, Sec 4 **(1)**
	L < 65	N.A.	• NR600	• NR600
Stability		• Part B • Ch 4, Sec 3, [1]	• Part B • Ch 4, Sec 3, [1]	• NR566 • Ch 4, Sec 3, [1]
Machinery and cargo systems		Part C	Part C	NR566
Electrical installations		Part C	Part C	NR566
Automation		Part C	Part C	NR566
Fire protection, detection and extinction		Part C	Part C	NR566

(1) Ch 4, Sec 4 is applicable to hatch covers.
Note 1:
NR566: Hull Arrangement, Stability and Systems for Ships less than 500 GT
NR600: Hull Structure and Arrangement for the Classification of Cargo Ships less than 65 m and Non Cargo Ships less than 90 m
NR606: Common Structural Rules for Bulk Carriers and Oil Tankers.

Ch 4, Sec 3, [5.2.2] (Amendments January 2015)

Delete "or NR600, as applicable" in the first paragraph of requirement [5.2.2].

Ch 4, Sec 3, [5.2.3] (Amendments January 2015)

Delete "or NR600, as applicable" in the second paragraph of requirement [5.2.3].

Ch 4, Sec 4, [2] (Amendments January 2015)

Delete "or NR600, as applicable" in requirements [2.1.1], [2.2.1] and [2.3.1].

Ch 4, Sec 4, [7] and Ch 4, Sec 4, [8] (Amendments January 2015)

Delete "or NR600, as applicable" in requirements [7.1.1], [7.2.1] and [8.1.1].

Ch 5, Sec 1, Table 1 (Amendments January 2015)

Replace the rows "Ship arrangement" and "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Greater than or equal to 500 GT	Less than 500 GT
Ship arrangement	$L \geq 65$ m	• Part B • Ch 5, Sec 2	• NR566 • Ch 5, Sec 2
	$L < 65$ m	• NR600	• NR566 • Ch 5, Sec 2
Hull	$L \geq 65$ m	• Part B • Ch 5, Sec 3	• Part B • Ch 5, Sec 3
	$L < 65$ m	• NR600	• NR600

Ch 5, Sec 3, [3.6.2] (Amendments January 2015)

Parenthesis opened with "to be used for ..." is to be closed after "or NR600, as applicable".

Ch 5, Sec 3, [5.3.1] (Amendments July 2015)

Replace "fine mesh" by "standard mesh" in the definition of σ.

Ch 6, Sec 1, Table 1 (Amendments January 2015)

Replace the rows "Ship arrangement" and "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Greater than or equal to 500 GT	Less than 500 GT
Ship arrangement	$L \geq 65$ m	• Part B • Ch 6, Sec 2	• NR566 • Ch 6, Sec 2
	$L < 65$ m	• NR600	• NR566 • Ch 6, Sec 2
Hull	$L \geq 65$ m	• Part B • Ch 6, Sec 3	• Part B • Ch 6, Sec 3
	$L < 65$ m	• NR600	• NR600

Ch 6, Sec 3, [3.4.2] (Amendments January 2015)

Parenthesis opened with "to be used for ..." is to be closed after "or NR600, as applicable".

Ch 6, Sec 3, [6.3.4], item a) (Amendments July 2015)

Replace "fine mesh" by "standard mesh" in the definition of σ.

Ch 6, Sec 3, [6.4.2] (Amendments January 2015)

Delete "or NR600, as applicable" at the end of requirement [6.4.2].

Ch 6, Sec 3, [9.1] (Amendments July 2015)

Replace requirement [9.1.1] by:

9.1.1 The use of aluminium coatings containing greater than 10% aluminium by weight in the dry film is prohibited in the cargo tanks, cargo tank deck area, pump rooms, cofferdams or any other area where cargo vapour may accumulate.

Ch 7, Sec 1 (Amendments July 2015)

Replace Table 1 by:

Table 1 : Applicable requirements

Item		Ships having the additional service feature **CSR**	Ships not having the additional service feature **CSR**	
			Greater than or equal to 500 GT	Less than 500 GT
Ship arrangement	L ≥ 65 m	• NR606 **(1)** • Ch 7, Sec 2	• Part B • Ch 7, Sec 2	• NR566 • Ch 7, Sec 2
	L < 65 m	N.A.	• NR600	• NR566 • Ch 7, Sec 2
Hull	L ≥ 65 m	• NR606 **(1)**	• Part B • Ch 7, Sec 3	• Part B • Ch 7, Sec 3
	L < 65 m	N.A.	• NR600	• NR600
Stability		• Part B • Ch 7, Sec 3	• Part B • Ch 7, Sec 3	• NR566 • Ch 7, Sec 3
Machinery and cargo systems		• Part C • Ch 7, Sec 4 **(2)**	• Part C • Ch 7, Sec 4 **(2)**	• NR566 • Ch 7, Sec 4 **(2)**
Electrical installations		• Part C • Ch 7, Sec 5	• Part C • Ch 7, Sec 5	• NR566 • Ch 7, Sec 5
Automation		• Part C	• Part C	• NR566
Fire protection, detection and extinction		• Part C • Ch 7, Sec 6	• Part C • Ch 7, Sec 6	• NR566 • Ch 7, Sec 6

(1) Refer to the scope of application of NR606.
(2) Ch 7, Sec 4 contains a table summarising the relaxations applying to certain service notations.
Note 1:
NR566: Hull Arrangement, Stability and Systems for Ships less than 500 GT
NR600: Hull Structure and Arrangement for the Classification of Cargo Ships less than 65 m and Non Cargo Ships less than 90 m
NR606: Common Structural Rules for Bulk Carriers and Oil Tankers.

Ch 7, Sec 1, [1.1] (Amendments July 2015)

Add the following requirement [1.1.5]:

1.1.5 Independent tanks

Ships designed with independent cargo tanks shall comply with the provisions of NR622 Structural Assessment of Independent Tanks and Supports for Asphalt Carrier.

Ch 7, Sec 3, [3.2.2] (Amendments January 2015)

Delete “or NR600, as applicable” at the end of requirements [3.2.2].

Ch 7, Sec 3, [4.3.5], item a) (Amendments July 2015)

Replace “fine mesh” by “standard mesh” in the definition of σ.

Ch 7, Sec 3, [4.4.2] (Amendments January 2015)

Delete “or NR600, as applicable” at the end of requirements [4.4.2].

Ch 7, Sec 3, [7.1] (Amendments July 2015)

Replace requirement [7.1.1] by:

7.1.1 The use of aluminium coatings containing greater than 10% aluminium by weight in the dry film is prohibited in the cargo tanks, cargo tank deck area, pump rooms, cofferdams or any other area where cargo vapour may accumulate.

Ch 7, Sec 4, [4.3.1], item b)

Replace reference to “Ch 7, Sec 6, [5.3.2]” by a reference to (new) “ Pt C, Ch 4, Sec 14, [13.2.1], item b)”.

Ch 7, Sec 4, [4.3.2], item d)

Replace reference to “Ch 7, Sec 6, [5.4.7], item f)” by a reference to (new) “ Pt C, Ch 4, Sec 14, [13.2.3], item b) 7)”.

Ch 7, Sec 4, [5.3.2]

Replace item a) in the alphanumeric list of requirement [5.3.2] by:

a) The discharge monitoring and control system is to be of a type approved in compliance with the provisions of IMO Resolution MEPC 108(49), as amended.

Ch 7, Sec 6

Replace Article [5] by:

5 Inert gas systems

5.1 Application

5.1.1 Ships where an inert gas system is required

a) *Ships having the service notations* ***oil tanker*** *or* ***FLS tanker*** *and of 8 000 tonnes deadweight and upwards are to be fitted with an inert gas system complying with the provisions of this Article, or with equivalent systems or arrangements in accordance with [5.1.2].*

b) *All tankers operating with a cargo tank cleaning procedure using crude oil washing are to be fitted with an inert gas system complying with the requirements of this Article.*

Such system is to be provided in every cargo tank and slop tank.

5.1.2 Requirements for equivalent systems

a) *For ships having the service notations* ***oil tanker*** *or* ***FLS tanker*** *and of 8 000 tonnes deadweight and upwards but less than 20,000 tonnes deadweight, the Society may accept other equivalent arrangements in accordance with item a) of [5.1.1] and following item b)*

b) *Equivalent systems or arrangements shall:*

- *be capable of preventing dangerous accumulation of explosive mixtures in intact cargo tanks during normal service throughout the ballast voyage and necessary in-tank operations, and*
- *be so designed as to minimize the risk of ignition from the generation of static electricity by the system itself.*

5.1.3 Ships where an inert gas system is fitted but not required

Inert gas systems provided on ships where such systems are not required by [5.1.1] are to comply with the provisions of [5.4].

5.2 General requirements

5.2.1 The inert gas system is to comply with the applicable requirements of Pt C, Ch 4, Sec 14, [13].

5.2.2 Plans in diagrammatic form are to be submitted for appraisal and are to include the following:

- details and arrangement of inert gas generating plant including all control monitoring devices
- arrangement of piping system for distribution of the inert gas.

5.2.3 An automatic control capable of producing suitable inert gas under all service conditions is to be fitted.

5.3 Additional requirements for nitrogen generator systems

5.3.1 The following requirements apply where a nitrogen generator system is fitted on board as required by [5.1.1]. For the purpose, the inert gas is to be produced by separating air into its component gases by passing compressed air through a bundle of hollow fibres, semi-permeable membranes or adsorber materials.

5.3.2 In addition to the applicable requirements of Pt C, Ch 4, Sec 14, [13], the nitrogen generator system is to comply with Ch 7, Sec 4, [4.3.2] and Ch 7, Sec 4, [4.2.11].

5.3.3 A nitrogen generator is to consist of a feed air treatment system and any number of membrane or adsorber modules in parallel necessary to meet the requirements of Pt C, Ch 4, Sec 14, [13.2.1], item b) 4).

5.3.4 The nitrogen generator is to be capable of delivering high purity nitrogen in accordance with Pt C, Ch 4, Sec 14, [13.2.1], item b) 5). In addition to Pt C, Ch 4, Sec 14, [13.2.2], item d), the system is to be fitted with automatic means to discharge “off-spec” gas to the atmosphere during start-up and abnormal operation.

5.3.5 The system is to be provided with one or more compressors to generate enough positive pressure to be capable of delivering the total volume of gas required by Pt C, Ch 4, Sec 14, [13.2.1], item b). Where two compressors are provided, the total required capacity of the system is preferably to be divided equally between the two compressors, and in no case is one compressor to have a capacity less than 1/3 of the total capacity required.

5.3.6 The feed air treatment system fitted to remove free water, particles and traces of oil from the compressed air as required by Pt C, Ch 4, Sec 14, [13.4.2], item b), is also to preserve the specification temperature.

5.3.7 The oxygen-enriched air from the nitrogen generator and the nitrogen-product enriched gas from the protective devices of the nitrogen receiver are to be discharged to a safe location on the open deck.

Note 1: “safe location” needs to address the two types of discharges separately:

- oxygen-enriched air from the nitrogen generator - safe locations on the open deck are:
  - outside of hazardous area;
  - not within 3m of areas traversed by personnel; and
  - not within 6m of air intakes for machinery (engines and boilers) and all ventilation inlets
- nitrogen-product enriched gas from the protective devices of the nitrogen receiver - safe locations on the open deck are:
  - not within 3m of areas traversed by personnel; and
  - not within 6m of air intakes for machinery (engines and boilers) and all ventilation inlets/outlets.

5.3.8 In order to permit maintenance, means of isolation are to be fitted between the generator and the receiver.

5.4 Nitrogen /inert gas systems fitted for purposes other than inerting required by [5.1.1]

5.4.1 Nitrogen/inert gas systems fitted on oil tankers of less than 8 000 tonnes deadweight and for which an inert gas system is not required by [5.1.1] are to comply with the following requirements.

5.4.2 Requirements of:

- Pt C, Ch 4, Sec 14, [13.2.2], item b)
- Pt C, Ch 4, Sec 14, [13.2.2], item d)
- Pt C, Ch 4, Sec 14, [13.2.4], item b)
- Pt C, Ch 4, Sec 14, [13.2.4], item c)
- Pt C, Ch 4, Sec 14, [13.2.4], item e) 1) regarding oxygen content and power supply to the indicating devices
- Pt C, Ch 4, Sec 14, [13.2.4], item e) 4)
- Pt C, Ch 4, Sec 14, [13.4.2] and
- Pt C, Ch 4, Sec 14, [13.4.3]

apply to the systems.

5.4.3 The requirements of [5.3] apply except requirements [5.3.1] to [5.3.3] and [5.3.5].

5.4.4 The two non-return devices as required by Pt C, Ch 4, Sec 14, [13.2.3], item a) 1) are to be fitted in the inert gas main. The non-return devices are to comply with Pt C, Ch 4, Sec 14, [13.2.3], item a) 2) and Pt C, Ch 4, Sec 14, [13.2.3], item a) 3); however, where the connections to the cargo tanks, to the hold spaces or to cargo piping are not permanent, the non-return devices required by Pt C, Ch 4, Sec 14, [13.2.3] item a) 1) may be substituted by two non-return valves.

Ch 8, Sec 3, [2.2.1]

Replace item b) in the alphanumeric list of requirement [2.2.1] by:

b) Access to forecastle spaces containing sources of ignition may be permitted through doors facing cargo area provided the doors are located outside hazardous areas as defined in IEC Publication 60092-502.

   However, for small ships alternative arrangements may be specially considered by the Society.

Ch 8, Sec 3, [4.1] (Amendments July 2015)

Replace requirement [4.1.1] by:

4.1.1 Independent cargo tanks

Where independent tanks are installed in hold spaces, requirements in [4.2] and [4.3] are to be applied, as far as practicable, to ballast and void spaces adjacent to hold spaces.

When such requirements are found to be incompatible with the size and arrangement of the ship, smaller dimensions may be accepted by the Society, providing convenient access to any part of those spaces is maintained.

Ch 8, Sec 4 (Amendments July 2015)

Replace the title of Article [3] by:

3 Hull scantlings

Ch 8, Sec 4, [7.1] (Amendments July 2015)

Replace requirement [7.1.1] by:

7.1.1

IBC CODE REFERENCE: CHAPTER 4

The use of aluminium coatings containing greater than 10% aluminium by weight in the dry film is prohibited in the cargo tanks, cargo tank deck area, pump rooms, cofferdams or any other area where cargo vapour may accumulate.

Ch 8, Sec 8, [3.1.1]

Replace the IBC CODE REFERENCE “Ch 8, 8.5” by “Ch 8, 8.6”.

Ch 8, Sec 9, [1.3]

Replace requirement [1.3.1] by:

1.3.1 Application

IBC CODE REFERENCE: Ch 9, 9.1

a) *Ships having the service notations **chemical tanker** and of 8 000 tonnes deadweight and upwards, carrying crude oil or petroleum products having a flashpoint not exceeding 60°C (closed cup test), as determined by an approved flashpoint apparatus, and a Reid vapour pressure which is below the atmospheric pressure, or other liquid products having a similar fire hazard, are to be equipped with an inert gas system complying with the requirements of Article [2], or with equivalent systems or arrangements in accordance with items b) and c).*

b) *For ships having the service notations **chemical tanker** and of 8 000 tonnes deadweight and upwards and of less than 20,000 tonnes deadweight, the Society may accept other equivalent arrangements in accordance with item a) and item c)*

c) *Equivalent systems or arrangements shall:*
   - *be capable of preventing dangerous accumulation of explosive mixtures in intact cargo tanks during normal service throughout the ballast voyage and necessary in-tank operations, and*
   - *be so designed as to minimize the risk of ignition from the generation of static electricity by the system itself.*

Ch 8, Sec 9, [1.3.4]

Replace item a) of the alphanumeric list in requirement [1.3.4] by:

a) In addition to the provisions in 9.1.3 of the IBC Code, the inert gas system is to comply with the requirements of Article [2]

Ch 8, Sec 9, [2]

Replace article [2] by:

2 Inert gas systems

2.1 General requirements

2.1.1 The inert gas system is to comply with the applicable requirements of Pt C, Ch 4, Sec 14, [13]

2.1.2 Plans in diagrammatic form are to be submitted for appraisal and are to include the following:

- details and arrangement of inert gas generating plant including all control monitoring devices
- arrangement of piping system for distribution of the inert gas

2.1.3 An automatic control capable of producing suitable inert gas under all service conditions is to be fitted

2.2 Additional requirements for nitrogen generator systems

2.2.1 The following requirements apply where a nitrogen generator system is fitted on board as required by [1.3.1]. For the purpose, the inert gas is to be produced by separating air into its component gases by passing compressed air through a bundle of hollow fibres, semi-permeable membranes or adsorber materials.

2.2.2 In addition to the applicable requirements of Pt C, Ch 4, Sec 14, [13], the nitrogen generator system is to comply with Ch 7, Sec 4, [4.3.2], and Ch 7, Sec 4, [4.2.11].

2.2.3 A nitrogen generator is to consist of a feed air treatment system and any number of membrane or adsorber modules in parallel necessary to meet the requirements of Pt C, Ch 4, Sec 14, [13.2.1], item b) 4).

2.2.4 The nitrogen generator is to be capable of delivering high purity nitrogen in accordance with Pt C, Ch 4, Sec 14, [13.2.1], item b) 5). In addition to Pt C, Ch 4, Sec 14, [13.2.2], item d), the system is to be fitted with automatic means to discharge "off-spec" gas tothe atmosphere during start-up and abnormal operation.

2.2.5 The system is to be provided with one or more compressors to generate enough positive pressure to be capable of delivering the total volume of gas required by Pt C, Ch 4, Sec 14, [13.2.1], item b). Where two compressors are provided, the total required capacity of the system is preferably to be divided equally between the two compressors, and in no case is one compressor to have a capacity less than 1/3 of the total capacity required.

2.2.6 The feed air treatment system fitted to remove free water, particles and traces of oil from the compressed air as required by Pt C, Ch 4, Sec 14, [13.4.2], item b), is also to preserve the specification temperature.

2.2.7 The oxygen-enriched air from the nitrogen generator and the nitrogen-product enriched gas from the protective devices of the nitrogen receiver are to be discharged to a safe location on the open deck.

Note 1: “safe location” needs to address the two types of discharges separately:

- oxygen-enriched air from the nitrogen generator - safe locations on the open deck are:
  - outside of hazardous area;
  - not within 3m of areas traversed by personnel; and
  - not within 6m of air intakes for machinery (engines and boilers) and all ventilation inlets
- nitrogen-product enriched gas from the protective devices of the nitrogen receiver - safe locations on the open deck are:
  - not within 3m of areas traversed by personnel; and
  - not within 6m of air intakes for machinery (engines and boilers) and all ventilation inlets/outlets.

2.2.8 In order to permit maintenance, means of isolation are to be fitted between the generator and the receiver.

2.3 Nitrogen /Inert gas systems fitted for purposes other than inerting required by [1.3.1]

2.3.1 Nitrogen/inert gas systems fitted on oil tankers of less than 8 000 tonnes deadweight and for which an inert gas system is not required by [1.3.1] are to comply with the following requirements.

2.3.2 Requirements of:

- Pt C, Ch 4, Sec 14, [13.2.2], item b)
- Pt C, Ch 4, Sec 14, [13.2.2], item d)
- Pt C, Ch 4, Sec 14, [13.2.4], item b)
- Pt C, Ch 4, Sec 14, [13.2.4], item c)
- Pt C, Ch 4, Sec 14, [13.2.4], item e) 1) regarding oxygen content and power supply to the indicating devices
- Pt C, Ch 4, Sec 14, [13.2.4], item e) 4)
- Pt C, Ch 4, Sec 14, [13.4.2] and
- Pt C, Ch 4, Sec 14, [13.4.3]

apply to the systems.

2.3.3 The requirements of [2.2] apply except requirements [2.2.1] to [2.2.3] and [2.2.5].

2.3.4 The two non-return devices as required by Pt C, Ch 4, Sec 14, [13.2.3], item a) 1) are to be fitted in the inert gas main. The non-return devices are to comply with Pt C, Ch 4, Sec 14, [13.2.3], item a) 2) and Pt C, Ch 4, Sec 14, [13.2.3], item a) 3); however, where the connections to the cargo tanks, to the hold spaces or to cargo piping are not permanent, the non-return devices required by Pt C, Ch 4, Sec 14, [13.2.3], item a) 1) may be substituted by two non-return valves.

Ch 8, Sec 15 (Amendments July 2015)

Delete Article [4].

Ch 9, Sec 3, [2.1]

Replace requirement [2.1.3] by:

2.1.3 Spaces located forward of the cargo area

IGC CODE REFERENCE: Ch 3, 3.2.4

Access to forecastle spaces containing sources of ignition may be permitted through doors facing cargo area provided the doors are located outside hazardous areas as defined in IEC Publication 60092-502

Ch 9, Sec 4, [2] (Amendments January 2015)

Replace twice "155000 m³" by "180000 m³" in requirement [2.2.2].

Replace sub-article [2.3] and Figure 5 by:

2.3 Sloshing pressure for membrane tanks of ships having a capacity less than 180000 m³

2.3.1 Standard filling levels

Standard filling levels are:

- full load condition:

  the liquid height in the cargo tank is comprised between 70% and 98% of the cargo tank height

- ballast condition:

  the liquid height in the cargo tank is comprised between 0% and 10% of the cargo tank height.

2.3.2 Pressures and tank regions

For standard filling levels, the sloshing pressure is to be obtained, in kN/m², from the following formula:

$p_s = p_{wi} + p_{pv}$

where:

p_{wi} : Quasi static pressure, in kN/m², taken equal to:

$p_{wi} = 240$ kN/m²

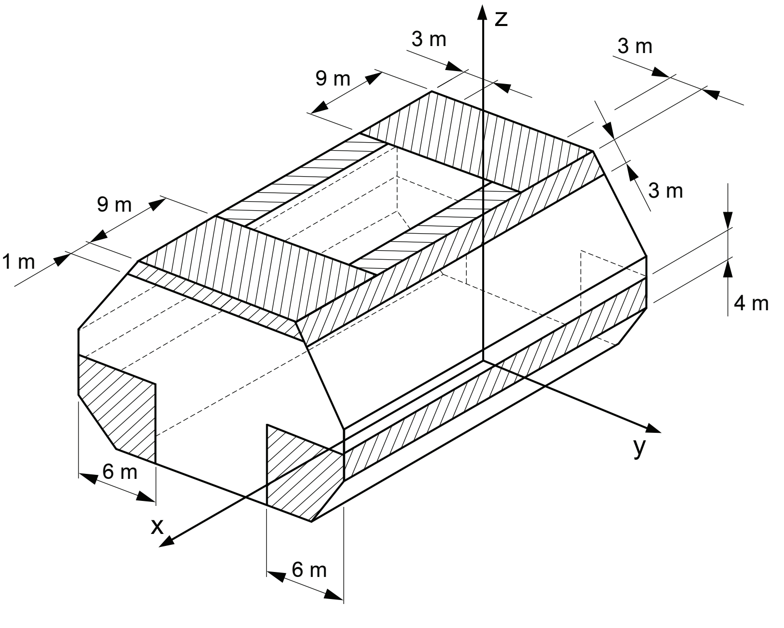
If duly justified (for example by numerical analysis and/or model tests), an other value of p_{wi} can be considered by the Society

p_{pv} : Setting pressure of safety valves, in kN/m².

The areas to be checked accordingly are described in Fig 5.

For filling levels other than standard filling levels, the sloshing pressure is to be specially considered by the Society.

Figure 5 : Areas to be checked for sloshing



Ch 9, Sec 4, Table 2 (Amendments July 2015)

Replace "Fine mesh" by "Standard mesh" in the last row of Table 2.

Ch 9, Sec 6, [1.2] (Amendments July 2015)

Replace requirement [1.2.1] by:

1.2.1

IGC CODE REFERENCE: CH 6, 6.2

The use of aluminium coatings containing greater than 10% aluminium by weight in the dry film is prohibited in the cargo tanks, cargo tank deck area, pump rooms, cofferdams or any other area where cargo vapour may accumulate.

Pt D, Ch 9, Sec 9, [2]

Replace sub-article [2.2] by:

2.2 Engineering specifications

2.2.1 Requirements of:

- Pt C, Ch 4, Sec 14, [13.2.2], item b)
- Pt C, Ch 4, Sec 14, [13.2.2], item d)
- Pt C, Ch 4, Sec 14, [13.2.4], item b)
- Pt C, Ch 4, Sec 14, [13.2.4], item c)
- Pt C, Ch 4, Sec 14, [13.2.4], item e) 1) regarding oxygen content and power supply to the indicating devices
- Pt C, Ch 4, Sec 14, [13.2.4], item e) 4)
- Pt C, Ch 4, Sec 14, [13.4.2] and
- Pt C, Ch 4, Sec 14, [13.4.3]

apply to the systems.

2.2.2 The nitrogen generator is to be capable of delivering high purity nitrogen in accordance with Pt C, Ch 4, Sec 14, [13.2.1], item b) 5). In addition to Pt C, Ch 4, Sec 14, [13.2.2] item d), the system is to be fitted with automatic means to discharge "off-spec" gas tothe atmosphere during start-up and abnormal operation.

2.2.3 The feed air treatment system fitted to remove free water, particles and traces of oil from the compressed air as required by Pt C, Ch 4, Sec 14, [13.4.2], item b), is also to preserve the specification temperature.

2.2.4 The oxygen-enriched air from the nitrogen generator and the nitrogen-product enriched gas from the protective devices of the nitrogen receiver are to be discharged to a safe location on the open deck.

Note 1: "safe location" needs to address the two types of discharges separately:

- oxygen-enriched air from the nitrogen generator - safe locations on the open deck are:
  - outside of hazardous area;
  - not within 3m of areas traversed by personnel; and
  - not within 6m of air intakes for machinery (engines and boilers) and all ventilation inlets
- nitrogen-product enriched gas from the protective devices of the nitrogen receiver - safe locations on the open deck are:
  - not within 3m of areas traversed by personnel; and
  - not within 6m of air intakes for machinery (engines and boilers) and all ventilation inlets/outlets.

2.2.5 In order to permit maintenance, means of isolation are to be fitted between the generator and the receiver.

2.2.6 The two non-return devices as required by Pt C, Ch 4, Sec 14, [13.2.3], item a) 1) are to be fitted in the inert gas main. The non-return devices are to comply with Pt C, Ch 4, Sec 14, [13.2.3], item a) 2) and Pt C, Ch 4, Sec 14, [13.2.3], item a) 3); however, where the connections to the cargo tanks, to the hold spaces or to cargo piping are not permanent, the non-return devices required by Pt C, Ch 4, Sec 14, [13.2.3], item a) 1) may be substituted by two non-return valves.

Ch 9, Sec 19, Table 1

Replace the rows "Acethaldehyde", "Butane" and "Ethylene oxide" in Table 1 by:

Table 1 : Additional information on products

Product name	Boiling temperature (°C)	Specific gravity at boiling point (kg/m^3)	Ratio vapour/air density
Acetaldehyde	20,8	780	1,52
N-butane / ISO-butane	−0,5 / −11,7	600	2,02
Ethylene oxide	10,7	870	1,52

Ch 10, Sec 1, Table 1 (Amendments January 2015)

Replace the rows "Ship arrangement" and "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Greater than or equal to 500 GT	Less than 500 GT
Ship arrangement	L ≥ 65 m	• Part B • Ch 10, Sec 2	• NR566 • Ch 10, Sec 2
	L < 65 m	• NR600	• NR566 • Ch 10, Sec 2
Hull	L ≥ 65 m	• Part B • Ch 10, Sec 2	• Part B • Ch 10, Sec 2
	L < 65 m	• NR600	• NR600

Ch 10, Sec 2, [5.4.1] and Ch 10, Sec 2, [5.5.2] (Amendments January 2015)

Delete "or NR600, as applicable" at the end of requirements [5.4.1] and [5.5.2].

Ch 11, Sec 1, Table 1 (Amendments January 2015)

Replace the rows "Ship arrangement" and "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Ships having the navigation notation **unrestricted navigation**	Ships having a navigation notation other than **unrestricted navigation**	
			Greater than or equal to 500 GT	Less than 500 GT
Ship arrangement	L ≥ 90 m	• Part B • Ch 11, Sec 2	• Part B • Ch 11, Sec 2	• NR566
	L < 90 m	• NR600	• NR600	• NR566
Hull	L ≥ 90 m	• Part B • Ch 11, Sec 3	• Part B • Ch 11, Sec 3	• Part B • Ch 11, Sec 3
	L < 90 m	• NR600	• NR600	• NR600

Ch 11, Sec 3, [5.1.1] (Amendments January 2015)

Delete "or NR600, as applicable" at the end of requirement [5.1.1].

Ch 11, Sec 3, Table 2 (Amendments January 2015)

Delete "or NR600, as applicable" at the end of footnote (1) in Table 2.

Ch 11, Sec 3, [5]

Delete the (new) sub-article [5.2] and (new) Table 3 (from Amendments January 2015). (Amendments July 2015)

Add the following sub-article [5.3]: (Amendments January 2015)

5.3 Freeboard deck

5.3.1 Flooding

The net thickness of plating and the net scantlings of ordinary stiffeners of freeboard deck are to be determined in accordance with the applicable requirements of Pt B, Ch 7, Sec 1 and Pt B, Ch 7, Sec 2, considering the flooding pressure defined in Pt B, Ch 5, Sec 6, [9.1.1].

Ch 12, Sec 1, Table 1 (Amendments January 2015)

Replace the rows "Ship arrangement" and "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Ships having the navigation notation **unrestricted navigation**	Ships having a navigation notation other than **unrestricted navigation**	
			greater than or equal to 500 GT	less than 500 GT
Ship arrangement	L ≥ 65 or 90 m **(1)**	• Part B • Ch 12, Sec 2	• Part B • Ch 12, Sec 2	• NR566
	L < 65 or 90 m **(1)**	• NR600	• NR600	• NR566
Hull	L ≥ 65 or 90 m **(1)**	• Part B • Ch 12, Sec 3	• Part B • Ch 12, Sec 3	• Part B • Ch 12, Sec 3
	L < 65 or 90 m **(1)**	• NR600	• NR600	• NR600

Ch 12, Sec 3, [3.1] (Amendments January 2015)

Delete the title of [3.1.1] and replace the title of [3.1] by:

3.1 Lowest 0,5 m of bulkheads forming vertical division along escape routes

Ch 12, Sec 3, Table 3 (Amendments January 2015)

Delete “or NR600, as applicable” at the end of footnote (1) in Table 3.

Ch 12, Sec 3, [5.1.2] (Amendments January 2015)

Replace references at the end of requirement [5.1.2] by:

according to Pt B, Ch 7, Sec 1, where the loads are defined in [3.1.1].

Ch 12, Sec 3, [5.2.1] (Amendments January 2015)

Replace references at the end of requirement [5.2.1] by:

according to Pt B, Ch 7, Sec 2, where the loads are defined in [3.1.1].

Ch 12, Sec 3, [5.3.2] (Amendments January 2015)

Replace references at the end of requirement [5.3.2] by:

according to Pt B, Ch 7, Sec 3, where the loads are defined in [3.1.1].

Ch 12, Sec 3, [5]

Delete the (new) sub-article [5.4] and (new) Table 4 (from Amendments January 2015). (Amendments July 2015)

Add the following sub-article [5.5]: (Amendments January 2015)

5.5 Freeboard deck

5.5.1 Flooding

The net thickness of plating and the net scantlings of ordinary stiffeners of freeboard deck are to be determined in accordance with the applicable requirements of Pt B, Ch 7, Sec 1 and Pt B, Ch 7, Sec 2, considering the flooding pressure defined in Pt B, Ch 5, Sec 6, [9.1.1].

Ch 13, Sec 1, Table 1 (Amendments July 2015)

*Replace the row "Hull" as follows and add the following table footnote **(1)**:*

Table 1 : Applicable requirements

Item		Greater than or equal to 500 GT	Less than 500 GT
Hull	L ≥ 65 or 90 m **(1)**	• Part B • Ch 13, Sec 2	• Part B • Ch 13, Sec 2
	L < 65 or 90 m **(1)**	• NR600 • Ch 13, Sec 2	• NR600 • Ch 13, Sec 2

(1) 90 m for ships assigned with the service notation **dredger** and 65 m for ships assigned with the service notation **hopper dredger**, **hopper unit**, **split hopper dredger** and **split hopper unit**.

Ch 13, Sec 2, [2.1.6] (Amendments July 2015)

Delete the first paragraph of requirement [2.1.6].

Ch 13, Sec 2, [4.1] (Amendments July 2015)

Replace requirement [4.1.1] by:

4.1.1 The hull girder strength of ships with one of the service notations **dredger**, **hopper dredger** or **hopper unit** is to be checked for navigation situation and dredging situation according to the criteria of Part B, Chapter 6, considering the still water and wave bending moments defined in [3.3].

Ch 13, Sec 2, [4.2.1] (Amendments July 2015)

Delete "or NR600, Ch 4, Sec 2, as applicable" in requirement [4.2.1].

Ch 13, Sec 2, [4] (Amendments July 2015)

Replace sub-article [4.3] by:

4.3 Ultimate strength check

4.3.1 The requirements of [4.3.2] apply only to:

- ships of more than 90 m and assigned with the service notation **dredger**
- ships of more than 65 m and assigned with one of the service notation **hopper dredger**, **hopper unit**, **split hopper dredger** or **split hopper unit**.

4.3.2 In addition to the requirements of Pt B, Ch 6, Sec 3, the ultimate strength of the hull girder is to be checked, in dredging situation, for ships complying with the following formula:

$$Z_{R,\,MIN} < \frac{|M_{SW,\,D}| + |M_{WV,\,D}|}{175/k} 10^{-3}$$

where:

$Z_{R,MIN}$: Minimum gross section modulus, in m³, defined in Pt B, Ch 6, Sec 2, [4.2.2]

$M_{SW,D}$: Vertical still water bending moment in dredging situation, in kN·m, as defined in [3.3.2], in hogging and sagging conditions

$M_{WV,D}$: Vertical wave bending moment in dredging situation, in kN·m, as defined in [3.3.3], in hogging and sagging conditions.

Ch 13, Sec 2, [5.1] (Amendments July 2015)

Replace requirement [5.1.2] by:

5.1.2 The hull section modulus, considered with the two half-hulls connected, is to be checked for navigation situation and dredging situation according to the criteria of Pt B, Ch 6, Sec 2, [4], considering the still water and wave bending moments defined in [3.4].

See also [4.2] for the determination of the midship section modulus.

Ch 13, Sec 2, [6.1.1] (Amendments July 2015)

Delete "or NR600, Ch 4, Sec 3, as applicable" in requirement [6.1.1].

Ch 13, Sec 2, [6.6.1] (Amendments July 2015)

Delete "or NR600, Ch 4, Sec 2, as applicable" in requirement [6.6.1].

Ch 13, Sec 2, [7.2.1], [7.2.2] and [7.2.3] (Amendments July 2015)

Delete "or NR600, as applicable" in requirements [7.2.1], [7.2.2] and [7.2.3].

Ch 13, Sec 2, Table 13 (Amendments July 2015)

Replace "Fine mesh" by "Standard mesh" in the last row of Table 13.

Ch 13, Sec 2, [11.1.1] and [11.2.1] (Amendments July 2015)

Delete "or NR600, Ch 5, Sec 2, as applicable" in requirements [11.1.1] and [11.2.1].

Ch 13, App 1, [2.1.1] (Amendments July 2015)

Replace reference to "Pt B, Ch 7, App 1" by "Pt B, Ch 7, App 1 or NR 600, Ch 4, Sec 5, [1.2]" in the first paragraph of requirement [2.1.1].

Ch 14, Sec 1, Table 1 (Amendments January 2015)

Replace the row "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Greater than or equal to 500 GT	Less than 500 GT
Hull	L ≥ 90 m	• Part B • Ch 14, Sec 2	• Part B • Ch 14, Sec 2
	L < 90 m	• NR600	• NR600

Ch 14, Sec 2, [2.4.1] (Amendments January 2015)

Delete "or NR600 as applicable" (twice) in requirement [2.4.1].

Ch 14, Sec 3, [4.5.1] (Amendments January 2015)

Replace "Pt B, Ch 5, Sec 5" by "Pt B, Ch 5, Sec 5 or NR600, as applicable," in requirement [4.5.1]

Ch 15, Sec 1, Table 2 (Amendments January 2015)

Replace the rows "Ship arrangement" and "Hull" in Table 2 by:

Table 2 : Applicable requirements

Item		Greater than or equal to 500 GT	Less than 500 GT
Ship arrangement	L ≥ 65 or 90 m **(1)**	• Part B • Ch 15, Sec 2	• NR566 • Ch 15, Sec 2
	L < 65 or 90 m **(1)**	• NR600	• NR566 • Ch 15, Sec 2
Hull	L ≥ 65 or 90 m **(1)**	• Part B • Ch 15, Sec 2	• Part B • Ch 15, Sec 2
	L < 65 or 90 m **(1)**	• NR600	• NR600

Ch 15, Sec 2, [2.2.1] (Amendments July 2015)

Replace Note 1 in item a) of the alphanumeric list in requirement [2.2.1] by:

Note 1: For ships which are also assigned with the additional service feature **LHNS** or **WS**, a cargo tank exclusively dedicated to the transport of pollution hazard only substances having a flashpoint exceeding 60°C (closed cup test) may be considered as a "similar space".

Replace item b) of the alphanumeric list by:

b) A cargo tank carrying exclusively oil products having a flashpoint exceeding 60°C (closed cup test) need not comply with item a), provided that the segregation requirements for accommodation spaces, drinking water and stores for human consumption are observed.

Ch 15, Sec 2, [2.3.2] (Amendments July 2015)

Replace Note 1 in item a) of the alphanumeric list in requirement [2.3.2] by:

Note 1: For ships which are also assigned with the service feature **oil product FP>60°C**, a cargo tank only dedicated to the transport of oil products having a flashpoint exceeding 60°C (closed cup test) may be considered as a "similar space".

Replace item e) of the alphanumeric list by:

e) For pollution hazard only substances having a flashpoint exceeding 60°C (closed cup test), the Society may waive the arrangements referred to in a), provided that the segregation requirements for accommodation spaces, drinking water and stores for human consumption are observed.

Ch 15, Sec 2, [3.1.1] (Amendments July 2015)

Replace the title of requirement [3.1.1] by:

3.1.1 Access to spaces adjacent to cargo tanks

Ch 15, Sec 2, [3.1.2] (Amendments July 2015)

Replace the title of requirement [3.1.2] by:

3.1.2 Direct access from open deck

Replace the first paragraph of item c) by:

c) For ships having the additional service feature **FP>60°C**, the following requirements may apply instead of items a) and b):

Delete items d), e) and f).

Ch 15, Sec 2, [3.1] (Amendments July 2015)

Add the following requirement [3.1.3]:

3.1.3 Dimension of access openings

The following requirements are applicable for all the spaces referred to in [3.1.2]:

a) For access through horizontal openings, hatches or manholes, the dimensions should be sufficient to allow a person wearing a self-contained air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the space. The minimum clear opening should be not less than 600 mm by 600 mm.

b) For access through vertical openings, or manholes providing passage through the length and breadth of the space, the minimum clear opening should be not less than 600 mm by 800 mm at a height of not more than 600 mm from the bottom shell plating unless gratings or other footholds are provided.

c) Smaller dimensions may be approved by the Society in special circumstances, if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Society.

Ch 15, Sec 2, [3.2] (Amendments July 2015)

Replace the title of requirement [3.2.1] by:

3.2.1 Access to spaces adjacent to cargo tanks

Replace requirement [3.2.2] by the following requirements [3.2.2] and [3.2.3]:

3.2.2 Direct access from open deck

a) Access to cofferdams, ballast tanks, cargo tanks and other spaces in the cargo area should be direct from the open deck and such as to ensure their complete inspection.

b) Access to double-bottom spaces may be through a cargo pump-room, pump-room, deep cofferdam, pipe tunnel or similar dry compartments, subject to consideration of ventilation aspects.

Note 1: In case of access to double-bottom spaces through pump rooms or cofferdam or pipe tunnel or similar spaces, these spaces are to be capable of being ventilated as requested in Ch 12.3 of the IBC Code.

3.2.3 Dimension of access openings

The following requirements are applicable for all the spaces referred to in [3.2.2]:

a) For access through horizontal openings, hatches or manholes, the dimensions should be sufficient to allow a person wearing a self-contained air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the space. The minimum clear opening should be not less than 600 mm by 600 mm.

b) For access through vertical openings, or manholes providing passage through the length and breadth of the space, the minimum clear opening should be not less than 600 mm by 800 mm at a height of not more than 600 mm from the bottom shell plating unless gratings or other footholds are provided.

c) Smaller dimensions may be approved by the Society in special circumstances, if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Society.

Ch 15, Sec 2, [7.1.2] (Amendments January 2015)

Delete “or NR600 as applicable” in the first paragraph of requirement [7.1.2].

Ch 15, Sec 2, [7.2.1] and Ch 15, Sec 2, [7.2.2] (Amendments January 2015)

Delete "or NR600 as applicable" at the end of requirements [7.2.1] and [7.2.2].

Ch 15, Sec 2, Table 8 (Amendments January 2015)

Delete "or NR600 as applicable" in the third column of Table 8.

Ch 15, Sec 2, [8.3.3] (Amendments January 2015)

Replace the reference "NR600" by "NR566" in the requirement [8.3.3].

Ch 15, Sec 2, [8.4.1] and Ch 15, Sec 2, [9.2.1] (Amendments January 2015)

Delete "or NR600 as applicable" in requirements [8.4.1] and [9.2.1].

Ch 15, Sec 3, [2.5]

Replace the requirement [2.5.1] by:

2.5.1 When provided, nitrogen/inert gas systems fitted on a supply vessel are to comply with the provision of Ch 7, Sec 6, [5.4.2] to Ch 7, Sec 6, [5.4.4].

Ch 16, Sec 1, Table 1 (Amendments January 2015)

Replace the row "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Greater than or equal to 500 GT	Less than 500 GT
Hull	L ≥ 90 m	• Part B • Ch 16, Sec 2	• Part B • Ch 16, Sec 2
	L < 90 m	• NR600	• NR600

Ch 17, Sec 1, Table 1 (Amendments January 2015)

Replace the rows "Ship arrangement" and "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Greater than or equal to 500 GT	Ships less than 500 GT
Ship arrangement	L ≥ 65 or 90 m **(1)**	• Part B • Ch 17, Sec 2	• NR566 • Ch 17, Sec 2
	L < 65 or 90 m **(1)**	• NR600	• NR566 • Ch 17, Sec 2
Hull	L ≥ 65 or 90 m **(1)**	• Part B • Ch 17, Sec 2	• Part B • Ch 17, Sec 2
	L < 65 or 90 m **(1)**	• NR600	• NR600

Ch 17, Sec 2, [3.1] (Amendments January 2015)

Replace requirement [3.1.2] by:

3.1.2 If lifting appliances are used during oil recovery operations, the scantling of their supporting structures is to be checked according to Pt B, Ch 1, Sec 1, [1.2].

Ch 18, Sec 1, Table 1 (Amendments January 2015)

Replace the row "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Greater than or equal to 500 GT	Less than 500 GT
Hull	L ≥ 65 or 90 m **(1)**	• Part B • Ch 18, Sec 2	• Part B • Ch 18, Sec 2
	L < 65 or 90 m **(1)**	• NR600	• NR600

Ch 19, Sec 1, Table 1 (Amendments January 2015)

Replace the row "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Greater than or equal to 500 GT	Less than 500 GT
Hull	L ≥ 65 or 90 m **(1)**	• Part B • Ch 19, Sec 2	• Part B • Ch 19, Sec 2
	L < 65 or 90 m **(1)**	• NR600	• NR600

Ch 19, Sec 2, [5.1.3] (Amendments January 2015)

Delete "or NR600 as applicable" in requirement [5.1.3].

Ch 19, Sec 2, [5.1] (Amendments July 2015)

Add the following requirement [5.1.4]:

5.1.4 Net section modulus and net shear sectional area of deck ordinary stiffeners subjected to a maximum allowable uniform pressure

Maximum allowable uniform pressure is to be submitted by the Designer.

In this particular load case, the net section modulus w, in cm^3, and the net shear sectional area A_{sh}, in cm^2, of deck longitudinal or transverse ordinary stiffeners are not to be less than the values obtained from the following formulae:

$$w = \gamma_R \gamma_m \beta_b \frac{\gamma_{S2} p_S + p_W}{12(R_y - 0.75\sigma_{X1})}\left(1 - \frac{s}{2\ell}\right) s \ell^2 10^3$$

$$A_{Sh} = 10 \gamma_R \gamma_m \beta_s \frac{\gamma_{S2} p_S + p_W}{R_y}\left(1 - \frac{s}{2\ell}\right) s \ell$$

where:

β_b, β_s : Coefficients defined in Pt B, Ch 7, Sec 2, [3.4.2]

γ_R, γ_m, γ_{S2} : Partial safety factors defined in Pt B, Ch 7, Sec 2

p_S : Still water deck pressure, as specified by the Designer and defined in Pt B, Ch 5, Sec 6, [4]

p_W : Inertial deck pressure defined in Pt B, Ch 5, Sec 6, [4].

Ch 19, Sec 2, [5.2] (Amendments January 2015)

Delete "or NR600 as applicable" in requirements [5.2.2] and [5.2.3].

Ch 19, Sec 2 (Amendments January 2015)

Delete Article [6], Table 2 and Table 3.

Ch 19, Sec 2, [7.1.1] (Amendments January 2015)

Delete "or NR600 as applicable" (four times) in requirement [7.1.1].

Ch 20, Sec 1, Table 1 (Amendments January 2015)

Replace the rows "Ship arrangement" and "Hull" in Table 1 by:

Table 1 : Applicable requirements

Item		Reference
Ship arrangement	L ≥ 65 or 90 m **(1)**	• Pt B • Ch 20, Sec 2
	L < 65 or 90 m **(1)**	• NR600
Hull	L ≥ 65 or 90 m **(1)**	• Pt B • Ch 20, Sec 3
	L < 65 or 90 m **(1)**	• NR600 • Ch 20, Sec 3, [2.4] Ch 20, Sec 3, [2.5] Ch 20, Sec 3, [2.6]

Ch 20, Sec 3, [2.2.1] (Amendments January 2015)

Delete "or NR600 as applicable" at the end of requirement [2.2.1].

Ch 20, Sec 3, [2.3.1] (Amendments January 2015)

Delete "or NR600 as applicable" in the first paragraph of requirement [2.3.1].

Replace the second paragraph by:

The net thickness of plating of the aft ramp and the lower part of the aft ramp side is to be not less than 11 mm.

Ch 20, Sec 3, [2.3.2] (Amendments January 2015)

Delete "or NR600 as applicable" in requirement [2.3.2].

Ch 20, Sec 3, [2] (Amendments January 2015)

Replace the title of sub-article [2.4] by:

2.4 Machinery casings for ships less than 65 m in length

Ch 20, Sec 3, [2.4.1] (Amendments January 2015)

Delete "or NR600 as applicable" at the end of requirement [2.4.1].

Ch 20, Sec 3, [2] (Amendments January 2015)

Replace the title of sub-article [2.5] by:

2.5 Hatch covers for ships less than 65 m in length

Ch 20, Sec 3, [2.5] (Amendments January 2015)

Insert the following requirement [2.5.1]:

2.5.1 Hatch cover arrangement and scantlings are to be in accordance with Pt B, Ch 8, Sec 7.

Ch 20, Sec 3, [2] (Amendments January 2015)

Replace the title of sub-article [2.6] by:

2.6 Arrangement for hull and superstructure openings for ships less than 65 m in length

Ch 20, Sec 3, [2.6.2] (Amendments January 2015)

Delete “or NR600 as applicable” in the first paragraph of requirement [2.6.2].

Ch 20, Sec 3, [3.3.3] and Ch 20, Sec 3, [4.1.1] (Amendments January 2015)

Delete “or NR600 as applicable” at the end of requirements [3.3.3] and [4.1.1].

Ch 20, Sec 6, [1.1]

Add the following requirement [1.1.2]:

1.1.2 When the Administration of the State whose flag the ship is entitled to fly has issued specific regulations covering fire protection, the Society may accept such regulations for classification purpose in lieu of those given in this Chapter.

In such cases, a memoranda indicating those specific regulations applied is issued.

Ch 21, Sec 2, [1.1.3] (Amendments July 2015)

Delete “is not fitted or” in the last paragraph of requirement [1.1.3].

Ch 21, Sec 3, [1] (Amendments July 2015)

Replace sub-article [1.3] by the following sub-articles [1.3] and [1.4]:

1.3 Progressive flooding

1.3.1 Application

Requirements [1.3.2] and [1.3.3] apply for offshore vessels for which damage stability is required.

1.3.2 Offshore patrol vessels with GT ≥ 500

Pt C, Ch 1, Sec 10, [5.5] is to be replaced by NR566, Ch 2, Sec 4, [5.9].

1.3.3 Offshore patrol vessels with GT < 500

Requirements as stated in NR566, Ch 2, Sec 4, [5.9] should apply.

1.4 Bilge pumping after flooding

1.4.1 Application

Requirements [1.4.2] and [1.4.3] apply for offshore vessels carrying more than 60 persons, for which damage stability is required.

1.4.2 Offshore patrol vessels with GT ≥ 500

In addition to the requirements as stated in Pt C, Ch 1, Sec 10, [6], provision of NR566, Ch 2, Sec 5, [1.6] should apply.

1.4.3 Offshore patrol vessels with GT < 500

Requirements as stated in NR566, Ch 2, Sec 5, [1.6] should apply.

Amendments to PART E

Chapter 1 (Amendments July 2015)

Replace the title of Section 1 by:

SECTION 1 VERISTAR-HULL, VERISTAR-HULL CM AND VERISTAR-HULL SIS

Ch 1, Sec 1, [1.1] (Amendments July 2015)

Replace requirement [1.1.1] by:

1.1.1 The additional class notation **VeriSTAR-HULL**, **VeriSTAR-HULL CM** and **VeriSTAR-HULL SIS** are assigned at the design stage or after construction. The notation **VeriSTAR-HULL SIS** is to be maintained during the service life.

These notations are granted to ships complying with the requirements of this Section, in accordance with Pt A, Ch 1, Sec 2, [6.2].

Ch 1, Sec 1, [1.2] (Amendments July 2015)

Replace reference "NR522 and NR523" by "NR606" in requirement [1.2.1].

Replace requirement [1.2.2] by the following requirements [1.2.2] and [1.2.3]:

1.2.2 The additional class notation **VeriSTAR-HULL CM** is assigned to a ship in order to reflect the following:

- the ship fulfils requirements of additional class notation **VeriSTAR-HULL**
- a hot spot map has been made available for construction surveys and is kept on board the ship after delivery.

1.2.3 The additional class notation **VeriSTAR-HULL SIS** is assigned to a ship in order to reflect the following:

- the ship fulfils requirements of additional class notation **VeriSTAR-HULL CM**
- the hull structure condition is periodically assessed, usually at the class renewal survey, using the results of the inspections and thickness measurements performed during the survey. The results of this assessment is made available to the Owner.

Ch 1, Sec 1, [2.1.1] (Amendments July 2015)

Replace references to "NR522 and NR523" by "NR606" in requirement [2.1.1].

Add ", as applicable" at the end of the fourth item in the bullet list of item a).

Delete the last item in the bullet list of item a).

Ch 1, Sec 1, [2.1] (Amendments July 2015)

Delete requirement [2.1.2].

Ch 1, Sec 1, [2] (Amendments July 2015)

Insert the following sub-article [2.2]:

2.2 VeriSTAR-HULL CM

2.2.1 General

The procedure for the assignment of the **VeriSTAR-HULL CM** notation to a ship is as follows:

a) The procedure described in [2.1.1] should be followed

b) The Interested Party submits to the Society a hot spot map as described in [2.2.2]

c) The Society reviews the hot spot map and, if satisfied with the results, grants the **VeriSTAR-HULL CM** notation.

2.2.2 Hot spot map

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 stresses from applied loads and the allowable limits exceeded 0,975
- items identified as "hot spot item" during structural reassessment, taking into account actual conditions revealed by updated thickness gaugings
- structural details subjected to fatigue, based on the list defined in Pt B, Ch 11, App 2 or NR606, Chapter 9. As a rule, only fatigue details with a calculated damage ratio above 0,5 are to be included in the hot spot map
- other items, depending on the results of the structural analyses and/or on experience.

Chapter 2 (Amendments July 2015)

Add the following Section 4:

SECTION 4 FIRE MITIGATION FOR MAIN DIESEL-GENERATOR ROOMS (AVM-FIRE)

1 General

1.1 Application

1.1.1 The additional class notation **AVM-FIRE** is assigned in accordance with Pt A, Ch 1, Sec 2, [6.3.5] to self-propelled ships arranged with means for maintaining a minimum of propulsion, steering, and habitability in case of fire in complying with the requirements of this Section.

1.1.2 Installation of machinery, electrical systems and automation is to comply with relevant provisions of Part C.

1.1.3 The additional class notation **AVM-FIRE** is assigned alone or in addition to the additional class notation **AVM-APS** or **AVM-DPS**.

1.2 Definitions

1.2.1 Propulsion system

A propulsion system is a system that provides thrust to the ship. It includes:

- prime mover, including the integral equipment, driven pumps, etc
- equipment intended to transmit the torque
- propulsion electric motor, where applicable
- equipment intended to convert the torque into thrust
- auxiliary systems necessary for operation
- control, monitoring and safety systems.

1.2.2 Steering system

A steering system is a system that controls the heading of the ship. It includes:

- power actuating system
- equipment intended to transmit the torque to the steering device
- steering device (e.g. rudder, rotatable thruster, waterjet steering deflector, etc.).

1.2.3 Propulsion auxiliary systems

Propulsion auxiliary systems include all the systems that are necessary for the normal operation of a propulsion system. Propulsion auxiliary systems include or may include:

- fuel oil supply system from, and including, the service tanks, and the parts of the filling, transfer and purifying systems located in machinery spaces
- lubricating oil systems serving the engines, the gearbox, the shaftline bearings, the stern tube, etc., and the parts of the lubricating oil filling, transfer and purifying systems located in machinery spaces
- hydraulic oil systems for operating clutches, controllable pitch propellers, waterjet reverse deflectors, starting systems, etc
- fresh water cooling systems serving any component of the propulsion system or used for cooling the fuel oil circuits, the lubricating oil circuits, the hydraulic oil circuits, etc
- sea water cooling systems used for cooling any component of the propulsion system or any of the aforementioned systems
- heating systems (using electricity, steam or thermal fluids)
- starting systems (air, electrical, hydraulic)
- control air systems
- power supply (air, electrical, hydraulic)
- control, monitoring and safety systems
- ventilation installation where necessary (e.g. to supply combustion air or cooling air to the primer movers).

1.2.4 Steering auxiliary systems

Steering auxiliary systems include all the systems that are necessary for the normal operation of a steering system. Steering auxiliary systems include or may include:

- fresh water cooling systems
- sea water cooling systems
- control air systems
- power supply (air, electrical, hydraulic)
- control, monitoring and safety systems.

1.2.5 Safety systems

Safety systems include all the systems that are necessary for the safety of the ship operation:

- fire fighting systems
- bilge system
- communication systems
- navigation lights
- life-saving appliances
- machinery safety systems which prevent any situation leading to fire or catastrophic damage.

Table 1 : Documents to be submitted

Item No.	I/A **(1)**	Document
1	I	Electrical load balance, including main diesel-generator room out of service
2	I	Machinery spaces general arrangement of main diesel-generator room, with main electrical components and cable routing
3	A	Single line diagrams of main electrical distribution system
4	A	A risk analysis demonstrating the availability of the concerned systems in case of fire in a main diesel-generator room (see [2.1]) **(2)**
5	I	An operating manual with the description of the operations necessary to recover the propulsion, steering and safety systems in case of fire in main diesel-generator room (see[2.1])
6	A	Structural fire protection arrangement of main diesel-generator rooms

(1) A : To be submitted for approval
I : To be submitted for information.
(2) The risk analysis may be in the form of a failure Mode and Effect analysis (FMEA). Ch 2, App 1 describes an acceptable procedure for carrying out the FMEA.

1.2.6 Habitability services

Services considered necessary for crew and passenger areas habitability include:

- sanitary water
- toilets
- ventilation
- HVAC
- galley facility
- provision rooms systems
- lighting.

1.2.7 Fire casualty

Fire casualty is to be considered only in one main diesel-generator room and limited to this single space.

1.3 Documents to be submitted

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

2 General design requirements

2.1 Principle

2.1.1 Machinery is to be so designed and arranged that, in case of any fire casualty occurring in one main diesel-generator room as defined in [1.2.7], sufficient operating functionality for propulsion, steering is still available as required in [2.3] and a minimum of 50% of the habitability services as defined in [1.2.6] remain operative.

2.1.2 Control stations of propulsion and steering system are to be arranged so as, in case of fire casualty occurring in one main diesel-generator rooms, the control of remaining propulsion and steering systems is still available.

2.1.3 Manual intervention may be accepted in order to make the systems available as required in [2.1.1] in the minimum possible time. In general, feasibility of manual actions should be demonstrated by tests or drills.

2.1.4 Compliance with requirements [2.1.1] and [2.1.2] is to be demonstrated by a risk analysis.

2.2 Electrical power plant

2.2.1 Main diesel-generators are to be distributed between at least two engine rooms.

2.2.2 Main diesel-generators and the main distribution system are to be arranged so that, in case of fire in one main diesel-generator room, the electrical power necessary to supply the systems defined in [1.2.1] to [1.2.6] remains available, in accordance with the principles detailed in [2.1].

2.2.3 Single failure and fire casualties in one main diesel-generator room leading to the loss of more than one generating set at one time may be accepted, provided that, after the failure, enough power still remains available to operate the ship under the conditions stated in [2.3.1] and [2.3.2] without any stand-by generating set still available. The recourse to the capacity of emergency source is not to be considered.

2.3 Propulsion and steering

2.3.1 In case of a fire casualty as defined in [1.2.7], sufficient propulsion power is to remain available to allow the ship to proceed at speed of not less than 7 knots, assuming:

- the ship is fully loaded
- normal weather conditions: BF 5.

2.3.2 The steering systems are to be so designed and arranged that, in case of fire casualty as defined in [1.2.7], not more than one steering system is disabled, thus allowing the steering capability to be continuously maintained.

2.4 Fire protection and detection

2.4.1 Each main diesel-generator room shall be surrounded by A60 bulkheads and overhead deck.

2.4.2 The fire detection might be lost only in the main diesel-generator room affected by the fire casualty and shall remain operational in all other spaces.

3 Tests on board

3.1 Operating tests

3.1.1 Each propulsion system, steering system as well as the power generation plant are to be subjected to the tests required by the Rules.

3.2 Sea trials

3.2.1 The propulsion machinery, steering machinery and the power generation plant are to undergo the following tests during the sea trials:

- tests required by the risk analysis conclusions and, where deemed necessary, simulation of certain single failures as well as certain manual actions as defined in [2.1.3]
- the values of the power and speed developed by the propulsion prime movers under test are to be recorded, as well as the electrical consumption.

Note 1: The speed is to be recorded with one propulsion system out of service, in order to verify the speed criteria required in [2.3.1].

Ch 3, Sec 1, Table 2 and Table 3 (Amendments July 2015)

Replace the title of Table 2 and Table 3 by:

Table 2 : Main propulsion cross-head (slow speed) diesel engine

Table 3 : Main propulsion trunk-piston (medium or high speed) diesel engine

Ch 3, Sec 1, Table 9 (Amendments July 2015)

Replace "Power limitation failure" by "Power limitation activated" in the first column of Table 9.

Ch 3, Sec 1 (Amendments July 2015)

Replace Table 28 by:

Table 28 : Auxiliary trunk-piston reciprocating I.C. engines driving generators

Symbol convention H = High, HH = High high, G = group alarm L = Low, LL = Low low, I = individual alarm X = function is required, R = remote (**AUT-CCS** only)	Monitoring		Automatic control				
			Engine			Auxiliary	
Identification of system parameter	Alarm	Indication	Slow-down	Shut-down	Control	Standby Start	Stop
Fuel oil viscosity or temperature before injection (for engine running on heavy fuel)	L + H	local					
					X		
Fuel oil pressure		local					
Common rail fuel oil pressure	L						
Fuel oil leakage from pressure pipes	H						
Lubricating oil temperature	H						
Lubricating oil pressure	L	local				X **(4)**	
	LL			X			
Oil mist concentration in crankcase **(1)** **(5)**	H			X			
Crankcase oil mist detector failure	X						
Exhaust gas temperature after each cylinder **(2)**	H	R	X				
Turbocharger lubricating oil inlet pressure **(2)** **(3)**	L	local					
Common rail servo oil pressure	L						
Pressure or flow of cooling system, if not connected to main system	L	local					
Temperature of cooling medium	H	local					
Level in cooling water expansion tank, if not connected to main system	L						
Engine speed		local					
					X		
	H			X			
Fault in the electronic governor system	X						

(1) For engines having a power of more than 2250 kW or a cylinder bore of more than 300 mm.
(2) For engine power > 500 kW/cyl.
(3) If without integrated self contained oil lubricating system.
(4) When a stand by pump is required.
(5) One oil mist detector for each engine having two independent outputs for initiating the alarm and shut-down would satisfy the requirement for independence between alarm and shut-down system.

Note 1: When the emergency generator is used in port, this Table applies.
Note 2: For engine driving emergency generator, see Pt C, Ch 1, Sec 2, Tab 5.

Ch 3, Sec 1, [1.1] (Amendments July 2015)

Replace requirement [1.1.3] by:

1.1.3 The requirements of this Section are additional to the general rule requirements applicable to the ships.

Ch 3, Sec 1, [1.1.4] (Amendments July 2015)

Delete the first item in the bullet list of requirement [1.1.4].

Ch 3, Sec 1, [1.2.1] (Amendments July 2015)

Replace reference "[1.3] and [5.4.3]" by "[5.4.3]" in requirement [1.2.1].

Ch 3, Sec 1, [1.2] (Amendments July 2015)

Replace requirement [1.2.2] by:

1.2.2 For ships whose gross tonnage is less than 500 and propulsive power per main engine less than 1 MW, the requirements laid down in [4], except [4.1.3], do not apply.

Diesel engines installed on ships are to be equipped with:

a) Indicators, as detailed below:
   - for auxiliary engine of 1000 kW and above:

     The requirements laid down in Pt C, Ch 1, Sec 2, Tab 2, Pt C, Ch 1, Sec 2, Tab 3 and Pt C, Ch 1, Sec 2, Tab 4 apply
   - for propulsion engine or auxiliary engine with a power less than 1000 kW:
     - lubrication oil pressure indication
     - fresh water temperature indication.

   The indicators are to be fitted at a normally centralised control position.

b) Alarms, as detailed below:
   - for auxiliary engine of 1000 kW and above:

     The requirements laid down in Pt C, Ch 1, Sec 2, Tab 2, Pt C, Ch 1, Sec 2, Tab 3 and Pt C, Ch 1, Sec 2, Tab 4 apply
   - for propulsion engine or auxiliary engine with a power less than 1000 kW:
     - lubrication oil low pressure alarm
     - very low lubricating oil pressure alarm
     - overspeed alarm.

   The alarms are to be visual and audible at a centralised control position.

c) Automatic control, as detailed below:
   - for auxiliary engine of 1000 kW and above:

     The requirements laid down in Pt C, Ch 1, Sec 2, Tab 2, Pt C, Ch 1, Sec 2, Tab 3 and Pt C, Ch 1, Sec 2, Tab 4 apply
   - for propulsion engine or auxiliary engine with a power less than 1000 kW:
     - shut-down on very low lubricating oil pressure
     - shut-down on overspeed.

Ch 3, Sec 1, [4.2] (Amendments July 2015)

Replace requirement [4.2.1] by:

4.2.1 When a diesel engine is used for the propulsion plant, monitoring and control of equipment is to be performed according to Tab 2 for cross-head (slow speed) engines or Tab 3 for trunk-piston (medium or high speed) engines.

Ch 4, Sec 1, Table 1 (Amendments July 2015)

*Delete reference to footnote **(2)** in rows No. 8 and No. 9 of Table 1.*

Ch 4, Sec 1, Table 2 (Amendments July 2015)

Replace the 12th and 13th rows of Table 2 as follows:

Table 2 : List of mandatory equipment

Equipment	Additional class notations	
	SYS-NEQ	**SYS-NEQ 1**
Alarm transfer system	–	yes, at least to master's cabin
Central alarm panel	–	yes

Ch 6, Sec 1, [1.2] (Amendments January 2015)

Insert the following requirement [1.2.2]:

1.2.2 For a series of ships, at least one comfort grade granting is to be made on the basis of measurements performed by an acoustic and vibration specialist from the Society.

Ch 6, Sec 1, [2.1.2]

Replace item a) of the alphanumeric list by:

a) General

Measurement and calibration equipment are to meet the requirements of ISO 2923, IEC 61672-1, IEC 61260 and IEC 60942 for noise, and ISO 6954 and ISO 8041 for vibration.

Sound insulation measurement is to be carried out according to ISO 16283-1.

Impact measurement is to be carried out according to ISO 140-7 and ISO 140-14.

Noise and vibration calibrators are to be verified at least every year. Measuring equipment are to be verified at least every two years. This verification is to be done by a national standard laboratory or a competent laboratory accredited according to ISO 17025 (2005) as corrected by (Cor 1:2006).

Ch 6, Sec 1, [2.1.3]

Replace item a) of the alphanumeric list by:

a) For noise level

The nominal noise level is evaluated with LAeq,T value.

LAeq,T (dB (A) re. 20μPa) is the equivalent continuous A weighted sound pressure level, T greater than 20 seconds.

Results are to be given on a table in global values (dB (A)) calculating in octave bands from 31,5 Hz to 8 kHz.

Ch 6, Sec 2

Replace the term "Engine control room" by "Engine control room or switchboard room (if continuously manned at sea)" in Table 1, Table 4, Table 5 and Table 6.

Ch 6, Sec 3

Replace the term "Engine control room" by "Engine control room or switchboard room (if continuously manned at sea)" in Table 2, Table 3, Table 4, Table 5 and Table 6.

Ch 6, Sec 3, [2.1.2] (Amendments January 2015)

Add the following paragraph at the end of item a) in requirement [2.1.2]:

For crew cabins within passenger ships, refer to Ch 6, Sec 4.

Ch 6, Sec 3, [3.1.2] (Amendments January 2015)

Add the following paragraph at the end of requirement [3.1.2]:

For crew cabins within passenger ships, refer to Ch 6, Sec 4.

Ch 6, Sec 4, [2.1.2]

Add the following Note 2 at the end of item a) in the alphanumeric list:

Note 2: The number of measuring points should not exceed 250.

Replace item c) in the alphanumeric list by:

c) Impact measurements
The selection of impact measuring locations is to be representative of the different deck coverings implemented on the ship and as provided in *(new)* Tab 2 (a minimum of two measurements of each deck covering is required). These measurements are dedicated to passenger cabins only.

Ch 6, Sec 4, Table 1

Insert the following row above row “Cabin to cabin with communication door (standard)”:

Table 1 : Apparent weighted sound reduction indexes R’w in dB

Locations	grade = 1	grade = 2	grade = 3
Cabin to cabin with communication door (top level)	44	41	39

Ch 6, Sec 4

Insert the following Table 2:

Table 2 : Weighted normalized impact sound pressure level L’n,w

Locations	L'n,w in dB
Cabin below public spaces covered with soft materials	50
Cabin below public spaces covered with hard materials (wood, marble, tiles, etc)	60
Cabin below sport rooms or dance floors	45

Ch 6, Sec 4, [2.4.1]

Replace requirement [2.4.1] by:

2.4.1 For cabins below public spaces, impact noise index is to be lower than the requirements given in *(new)* Tab 2. Measurements are to be performed in situ, ship at quay or at anchorage.

Ch 6, Sec 4, [3.1.2]

Add the following Note 2 after the existing Note 1:

Note 2: The number of measuring points should not exceed 250.

Ch 8, Sec 1 (Amendments July 2015)

Replace Article [1] by:

1 General

1.1 Application

1.1.1 The following additional class notations are assigned in accordance with Pt A, Ch 1, Sec 2, [6.10] to ships strengthened for navigation in ice and complying with the relevant requirements of this Chapter:

- **ICE CLASS IA SUPER**
- **ICE CLASS IA**
- **ICE CLASS IB**
- **ICE CLASS IC**
- **ICE CLASS ID**
- **YOUNG ICE 1**
- **YOUNG ICE 2**

1.1.2 The ice strengthening requirements in this Chapter, excepting those for ships with the additional class notation **ICE CLASS ID**, **YOUNG ICE 1** or **YOUNG ICE 2**, are equivalent to those stated in the Finnish-Swedish Ice Class Rules 2010, as amended, applicable to ships trading in the Baltic Sea in winter or equivalent ice conditions.

1.1.3 As a guidance, Tab C provides relation between the additional class notations **YOUNG ICE 1** and **YOUNG ICE 2** and the associated ice conditions compatible with the strengthening requirements in Sec 2, [7].

1.2 Owner's responsibility

1.2.1 It is the responsibility of the Owner to decide which ice class notation is the most suitable in relation to the expected service conditions of the ship.

Nevertheless, it is to be noted that a ship assigned with **ICE CLASS IA SUPER** is not to be considered as a ship suitable for navigation in ice in any environmental condition, such as an icebreaker.

Insert the following Table C:

Table C : Ice conditions for YOUNG ICE 1 and YOUNG ICE 2

Notation	Ice forming stage	Ice concentration
YOUNG ICE 1	Young ice (gray or whitish) having a maximum thickness of 30 cm	Open ice (concentration between 6 and 3/10th)
YOUNG ICE 2		Very open ice (concentration less than 3/10th)

Ch 8, Sec 1, [3.1.1] (Amendments July 2015)

Add the following paragraph at the end of requirement [3.1.1]:

No minimum engine output is required for notations **ICE CLASS ID**, **YOUNG ICE 1** and **YOUNG ICE 2**.

Ch 8, Sec 1, [3.1.2] (Amendments July 2015)

Replace the symbol name H_B in the last definition by H_F.

Ch 8, Sec 2 [1.1] (Amendments July 2015)

Add the following requirement [1.1.4]:

1.1.4 Additional class notations YOUNG ICE 1 and YOUNG ICE 2

Ships with the additional class notation **YOUNG ICE 1** or **YOUNG ICE 2** are to comply with the requirements defined in [7].

The other articles of this Section are not applicable to notations **YOUNG ICE 1** and **YOUNG ICE 2**.

The miscellaneous requirements listed in Ch 8, Sec 3, [3] are also to be complied with.

Ch 8, Sec 2 (Amendments July 2015)

Add the following Article [7], Table 11, Table 12 and Table 13:

7 Additional class notations YOUNG ICE 1 and YOUNG ICE 2

7.1 Area to be strengthened

7.1.1 Region

For the purpose of the assignment of the notations **YOUNG ICE 1** and **YOUNG ICE 2**, only the bow region of the ship, as defined in [1.2.1], is to be strengthened.

7.1.2 Vertical extension

The vertical extension of the ice strengthened area is defined in Tab 11 for plating, ordinary stiffeners and primary supporting members.

7.2 Design loads

7.2.1 Height of the ice load area

A ship strengthened for assignment of additional class notation **YOUNG ICE 1** or **YOUNG ICE 2** is assumed to operate in conditions corresponding to ice thickness not exceeding the value h_0.

The design ice load height h of the area under ice pressure at any time is assumed to be only a fraction of the ice thickness.

The values for h_0 and h, in m, are given in Tab 12.

Table 11 : Vertical extension of ice strengthened area for plating, ordinary stiffeners and primary supporting members

Notation	Hull region	Vertical extension of ice strengthened area, in m	
		above UIWL	below LIWL
YOUNG ICE 1 **YOUNG ICE 2**	Bow	0,40	0,50

Table 12 : Ice load height

Notation	h_0 (m)	h (m)
YOUNG ICE 1 **YOUNG ICE 2**	0,30	0,19

7.2.2 Ice loads

The design ice pressure p, in N/mm², is to be calculated according to [3.2], considering the following replacement parameters:

C_p : Coefficient taking account of the probability of the design ice pressure occurring in a particular region of the hull for the additional class notation considered, defined in Tab 13

p_0 : Nominal ice pressure, in N/mm², to be taken equal to 3,0.

Table 13 : Coefficient C_p

Notation	C_p
YOUNG ICE 1	0,6
YOUNG ICE 2	0,3

7.3 Plating

7.3.1 General

If the scantlings obtained from [7.3.2] are less than those required for the unstrengthened ship, the latter are to be used.

The scantling formulae defined in [7.3.2] are based on simply supported boundary conditions to take into account non-homogeneous ice loads. Different boundary conditions will be considered on a case-by-case basis.

7.3.2 Plating thickness in the ice strengthened area

The thickness of the shell plating made of steel or aluminium is to be not less than the value obtained, in mm, from the following formulae:

- for transverse framing:

$$t = 27,4s\sqrt{\frac{F_1 p_{pl} 10^3}{R}} + t_c$$

- for longitudinal framing:

$$t = 27,4\sqrt{\frac{p_{pl} h(2s-h)10^3}{F_2 R}} + t_c$$

where:

p_{pl} : Ice pressure on the shell plating, in N/mm², to be taken equal to 0,75 p

F_1 : Coefficient to be obtained from the following formula:

$$F_1 = 1,3 - \frac{4,2}{\left[\frac{h}{s} + 1,8\right]^2}$$

without being taken greater than 1,0

F_2 : Coefficient to be obtained from the following formulae:

- for h/s ≤ 1,0:

$$F_2 = 0,6 + 0,4\frac{s}{h}$$

- for 1,0 < h/s < 1,8:

$$F_2 = 1,4 - 0,4\frac{h}{s}$$

R : Minimum yield stress value of the material, in N/mm², taken equal to:

- for steel:

  $R = R_{eH}$ as defined in Pt B, Ch 4, Sec 1, [2]

- for aluminium:

  $R = R'_{p0,2}$ as defined in Pt B, Ch 4, Sec 1, [4]

t_c : Abrasion and corrosion addition, in mm, to be taken equal to 2 mm for steel and aluminium; where a special surface coating, shown by experience to be capable of withstanding the abrasion of ice, is applied, a lower value may be accepted by the Society on a case-by-case basis.

7.4 Ordinary stiffeners and primary supporting members

7.4.1 General

If the scantlings obtained from [7.4.2] and [7.4.3] are less than those required for the unstrengthened ship, the latter are to be used.

The scantling formulae defined in [7.4.2] and [7.4.3] are based on simply supported boundary conditions to take into account non-homogeneous ice loads. Direct calculation approach may be considered for different boundary conditions.

Where less than 15% of the span ℓ of an ordinary stiffener or a primary supporting member is located within the ice-strengthening zone defined in [7.1], their scantlings may be determined according to the applicable requirements for the unstrengthened ship or by direct calculation.

The effective shear section of welded connections between secondary stiffeners and primary supporting members is to be not less than the A_{sh} values calculated in [7.4.2] or [7.4.3], as relevant. When these criteria cannot be fulfilled, brackets or collar plates are to be fitted.

7.4.2 Scantlings of transverse stiffeners

The section modulus W, in cm³, and the effective shear area A_{sh} , in cm², of transverse stiffeners within the ice belt and subject to ice loads are to be not less than the values obtained from the following formulae:

$$W = \frac{phs(2\ell - h)10^6}{8R}$$

$$A_{sh} = \frac{10psh}{0,6R}10^3$$

where:

R : Minimum yield stress value of the material, in N/mm², taken equal to:

- for steel:

  $R = R_{eH}$ as defined in Pt B, Ch 4, Sec 1, [2]

- for aluminium:

  $R = R'_{p0,2}$ as defined in Pt B, Ch 4, Sec 1, [4].

7.4.3 Scantlings of longitudinal stiffeners

The section modulus W, in cm³, and the effective shear area A_{sh} , in cm², of longitudinal stiffeners within the ice belt and subject to ice loads are to be not less than the values obtained from the following formulae:

$$W = \frac{ph\ell^2 10^6}{8R}$$

$$A_{sh} = \frac{5ph\ell}{0,6R}10^3$$

7.5 Sidescuttles and freeing ports

7.5.1 Sidescuttles are not to be located in the ice strengthened area.

7.5.2 Freeing ports are to be given at least the same strength as the one required for the shell in the ice belt.

Ch 9, Sec 1, Table 2

*Replace rows "**CLEANSHIP / CLEANSHIP SUPER**" and "**EGCS-SCRUBBER**" as follows:*

Table 2 : Required certificates

Notations	Certificate	Applicable Rules and Regulations
CLEANSHIP **CLEANSHIP SUPER**	IOPP certificate **(1)**	Annex I of MARPOL 73/78, Appendix II
	Type approval certificate of: • 15 ppm bilge separator • 15 ppm bilge alarm	IMO Resolution MEPC.107(49): • Part 1 of the Annex • Part 2 of the Annex
	ISPP certificate **(1)**	Annex IV of MARPOL 73/78, Appendix
	Type approval certificate of the sewage system	IMO Resolution MEPC.227(64)
	Type approval certificate of the incinerator **(2)**	• IMO Resolution MEPC.76(40) as amended by Resolution MAPC.93(45) • Annex VI of MARPOL 73/78, Appendix IV
	IAPP certificate **(1)**	• Annex VI of MARPOL 73/78, Appendix I • IMO Resolution MEPC.194(61)
	EIAPP certificates of diesel engines **(3) (4)**	NOx Technical Code 2008, Appendix I
	SOx emission compliance certificate Certificate of unit approval for exhaust gas cleaning system **(5)**	IMO Resolution MEPC.259(68)
	IAFS certificate or Declaration on Anti-fouling system	International Convention on the control of Harmful and Anti-fouling systems, 2001, Annex 4, Appendices 1and 2
EGCS-SCRUBBER	• Exhaust gas cleaning unit Technical Manual (ETM) for unit • Onboard Monitoring Manual (OMM) • SOx Emission Compliance Plan (for ship, SECP) • SOx Emission Compliance Certificate (SECC, only for units approved on scheme A)	IMO Resolution MEPC.259(68)

Ch 9, Sec 1, Table 3

*Replace rows "**CLEANSHIP / CLEANSHIP SUPER**","**EGCS-SCRUBBER**" and "**VCS**" as follows:*

Table 3 : Required operational procedures

Notations	Operational procedure	Applicable Rules and Regulations
CLEANSHIP **CLEANSHIP SUPER**	Shipboard oil pollution emergency plan **(1)**	IMO Resolution MEPC.54(32) as amended by Resolution MEPC.86(44)
	Procedure to prepare and maintain an oil record book **(1)**	Annex I of MARPOL 73/78, Appendix III
	Procedure to maintain, operate and troubleshoot bilge water treatment systems	IMO Circular MEPC.1/Circ.677
	Bunkering procedure	–
	Measures to prevent oil pollution	–
	Sewage and grey water management plan and discharge control plan **(1)**	IMO Resolution MEPC.157(55)
	Garbage management plan including procedures to prepare and maintain a garbage record book and hazardous waste procedures **(1)**	• IMO Resolution MEPC.70(38) • IMO Circular MEPC/Circ.317 • Annex V of MARPOL 73/78, Appendix • IMO Resolution MEPC.92(45)
	Operating procedure to be followed to minimise the risk and the consequences of ozone-depleting refrigerant leakage, under normal and emergency conditions, including: • checking of the piping tightness • recharge • detection of leakage • maintenance and repair **(2)**	–
	Procedure to prepare and maintain the ozone-depleting substances record book	–
	NOx emission control plan	–
	Fuel oil quality management plan	• Annex VI of MARPOL 73/78, Regulation 18 and Appendix VI • IMO Resolution MEPC.182(59)
	Where an exhaust gas cleaning (EGC) system is used: • SOx emission compliance plan • Onboard monitoring manual • Procedure to prepare and maintain the EGC record book	IMO Resolution MEPC.259(68)
EGCS-SCRUBBER	• Exhaust gas cleaning unit Technical Manual (ETM) for unit • Onboard Monitoring Manual (OMM) • EGC record book or Electronic Logging system	IMO Resolution MEPC.259(68)
VCS	VOC management plan	• IMO Resolution MEPC.185(59) • IMO Circular MEPC.1/Circ.680

Pt E, Ch 9, Sec 2, [2.2.2] (Amendments July 2015)

Replace the third paragraph of requirement [2.2.2] by:

For ships operating with heavy fuel oil having a relative density greater than 0,94 at 15°C, the bilge water holding tank is to be fitted with heating facilities, except if the oily water separator capability to efficiently treat the oily water at ambient temperatures (without heating) is justified.

Ch 9, Sec 2, [2.3.4]

Replace reference to "MEPC.159(55)" by a reference to "MEPC.227(64)".

Pt E, Ch 9, Sec 2, [2.6.2] (Amendments July 2015)

Insert the following Note 1:

Note 1: As an alternative to the overflow system, the Society may accept spill deck containment system in way of the concerned tank, provided it has a capacity:

- of at least that required in [2.6.3], and
- commensurate with the maximum expected filling flow rate of the tank and the time necessary to activate the shutdown of the transfer pump in case of high level in the tank.

Pt E, Ch 9, Sec 2, [2.6.3] (Amendments July 2015)

Add the following Note 1 at the end of requirement [2.6.3]:

Note 1: As an alternative arrangement to the closed drainage system, the Society may accept manual draining by gravity or by means of a portable pump, in conjunction with a suitable procedure covering the draining operation, the disposal of the drained oil and the cleaning of the container.

Ch 9, Sec 2, [2.10.3]

Replace reference to "MEPC.184(59): 2009 Guidelines for exhaust gas cleaning systems" by a reference to "MEPC.259(68): 2015 Guidelines for exhaust gas cleaning systems".

Ch 9, Sec 2, [3.8.1]

Replace reference to "MEPC.184(59)" by a reference to "MEPC.259(68)" in the second item of the bulleted list and in Note 1.

Ch 9, Sec 3, [2] (Amendments January 2015)

Replace sub-article [2.2] by:

2.2 Definitions and abbreviations

2.2.1 BOD5

BOD5 means 5-day Biochemical Oxygen Demand.

BOD_5 is the amount, in milligrams per litre, of oxygen used in the biochemical oxidation of organic matter in five days at 20°C.

2.2.2 Thermotolerant coliforms (TC)

Thermotolerant coliforms means the group of coliform bacteria which produce gas from lactose in 48 hours at 44.5°C.

Note 1: Thermotolerant coliforms are sometimes referred to as "fecal coliforms". The term thermotolerant coliforms is now accepted as more appropriate, since not all of these organisms are of faecal origin.

2.2.3 TRC

TRC means Total Residual Chlorine. TRC is the chlorine remaining in wastewater at the end of a specified contact period as combined or free chlorine.

2.2.4 TSS

TSS is the pollutant parameter total suspended solids.

Ch 9, Sec 3, [2.3] (Amendments January 2015)

Replace requirements [2.3.2] and [2.3.3] by the following requirement [2.3.2]:

2.3.2 Type approval

Advanced Wastewater Treatment plants are to be of a type approved in accordance with the effluent standards given in Tab 1.

Ch 9, Sec 3

Replace (new) Table 1 (from Amendments July 2015) by:

Table 1 : Effluent standards for the type approval of advanced wastewater treatment plants

Parameter	Limit	Reference of the standard
Thermotolerant Coliform (TC)	14 TC / 100 ml **(1)**	Alaska Department of Environmental Conservation - General permit 2013DB0004, effective August 29, 2014
Total Suspended Solid (TSS)	30 Q_i/Q_e mg/l **(1) (2)**	Alaska Department of Environmental Conservation - General permit 2013DB0004, effective August 29, 2014
5-day Biochemical Oxygen Demand (BOD_5)	25 Q_i/Q_e mg/l **(1) (2)**	IMO Resolution MEPC.227(64)
Chemical Oxygen Demand (COD)	125 Q_i/Q_e mg/l **(2)**	IMO Resolution MEPC.227(64)
pH	between 6,0 and 8,5	IMO Resolution MEPC.227(64)
Total Residual Chlorine (TRC)	7,5 µg/l	Alaska Department of Environmental Conservation - General permit 2013DB0004, effective August 29, 2014
Total nitrogen	20 Q_i/Q_e mg/l or at least 70% reduction **(2) (3)**	IMO Resolution MEPC.227(64)
Total phosphorus	1,0 Q_i/Q_e mg/l or at least 80% reduction **(2) (3)**	IMO Resolution MEPC.227(64)

(1) Geometric mean of the samples taken during the test period.
(2) The dilution factor Q_i/Q_e is equal to the ratio of the influent Q_i (sewage, grey water and other liquid streams to be processed by the treatment plant) to the effluent Q_e (treated wastewater produced by the treatment plant).
(3) Reduction in relation to the load of the influent.

Ch 9, Sec 3, [5.2]

Replace reference to "MEPC.159(55)" by a reference to "MEPC.227(64)" in requirements [5.2.2] and [5.2.3].

Ch 9, Sec 3, [6.2.1]

Replace Note 2 in requirement 6.2.1] by:

Note 2 : Discharge of washwaters from exhaust gas cleaning (EGC) systems is not allowed during the no discharge operation. The installation of closed loop EGC systems may be considered in this respect.

Ch 9, Sec 3, [9.2.2] and Ch 9, Sec 3, [10.2.1]

Replace reference to "MEPC.184(59)" by a reference to "MEPC.259(68)" in requirements [9.2.2] and [10.2.1].

Ch 9, Sec 4 (Amendments January 2015)

Replace Table 1, Table 2, Table 3 and Table 4 by:

Table 1 : Frequency of analyses of waste streams during the first year of service

Waste stream	Frequency of analyses
Metals analyses in incinerator ash **(1)**	quarterly
Metals analyses in grey water	quarterly
Effluent analyses sewage treatment plan	yearly
Effluent analyses for Advanced Wastewater Treatment **(2)**	quarterly

(1) If the ship is equipped to dump incinerator ash overboard.
(2) Applies only to ships having the additional class notation **AWT**.

Table 2 : Frequency of analyses of waste streams after the first year of service

Waste stream	Number of analyses in a 5-year period
Metals analyses in incinerator ash **(1)**	2
Metals analyses in grey water	2
Effluent analyses sewage treatment plan	2
Effluent analyses for Advanced Wastewater Treatment **(2)**	20
Oil content analyses of machinery bilge water	2

(1) If the ship is equipped to dump incinerator ash overboard.
(2) Applies only to ships having the additional class notation **AWT**.

Table 3 : Permissible number of analyses exceeding limit values

Number of analyses in a 5-year period	Maximum number of analyses above limit
2-5	0
20	2

Table 4 : Biological analyses standard for waters

Water to be tested	Pollutant	Limit concentration	Reject value
Effluent of oil filtering equipment	Oil	15 ppm	–
Effluent of sewage treatment plant	Thermotolerant Coliforms (TC)	100 TC/100 ml	–
	Total Suspended Solids (TSS)	35 mg/l	–
	5-day Biochemical Oxygen Demand (BOD_5)	25 mg/l	–
	Chemical Oxygen Demand (COD)	125 mg/l	
Effluent of AWT unit (applies only to ships having the additional class notation **AWT**)	Thermotolerant Coliforms (TC)	14 TC/100 ml	40 TC/100 ml
	Total Suspended Solids (TSS)	30 mg/l	150 mg/l
	5-day Biochemical Oxygen Demand (BOD_5)	25 mg/l	60 mg/l
	Chlorine	7,5 µg/l	100 µg/l

Ch 10, Sec 1, [3.2.1]

Replace the formula of A_{Sh} in the second item of the bulleted list by:

$$A_{Sh} = 10\gamma_R\gamma_m\beta_s\frac{\gamma_{S2}p_S + \gamma_{W2}p_W}{0,65R_y}s\ell$$

Ch 10, Sec 5, [2.2.3] (Amendments July 2015)

Replace the formula of Q in item a) of requirement [2.2.3] by:

$$Q = \frac{590}{1,4a_{Y2}n_{w2}}$$

Replace the formula of Q in item b) by:

$$Q = \frac{500}{1,4a_{Y2}n_{w2}}$$

Insert the following definition of n_{w2} after the definition of a_{Y2}:

n_{w2} : Coefficient as defined in [4.3.4].

Ch 10, Sec 5, [2.4.9] (Amendments July 2015)

Replace the formula of Q in item a) of requirement [2.4.9] by:

$$Q = \frac{590}{1,4a_{Y2}n_{w2}}$$

Replace the formula of Q in item b) by:

$$Q = \frac{500}{1,4a_{Y2}n_{w2}}$$

Add, at the end of requirement [2.4.9]:

n_{w2} : Coefficient as defined in [4.3.4].

Besides, in inclined condition, ($a_{y2} \cdot n_{w2}$) is to be taken not less than 0,35 g for container bays located on deck, and:

- on single island designs, aft of the forward bulkhead of the engine room and forward of 0,65 L
- on twin island designs, outside of the region between the two islands.

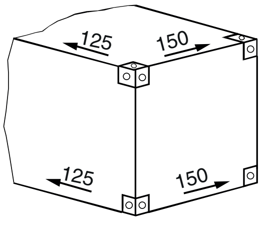
Ch 10, Sec 5, [4.3.5] (Amendments July 2015)

Replace a_{Y2} by ($a_{Y2} \cdot n_{w2}$) in the sentence introducing the second bullet list of requirement [4.3.5].

Ch 10, Sec 5 (Amendments January 2015)

Replace Figure 9 by:

Figure 9 : Permissible transverse and longitudinal racking loads on frames of 20' and 40' containers



Ch 10, Sec 5, [6.4.1]

Add the following Note 1 at the end of requirement [6.4.1]:

Note 1: For ships granted with the additional class notation **LASHING-WW** or **LASHING (restricted area)**, the force applied to each piece of lashing equipment needs not exceed the resulting force calculated considering unrestricted navigation conditions.

Ch 10, Sec 6, [5.4.2] (Amendments July 2015)

Replace "IMO Resolutions A525 (13), A 694 (17) and A 813 (19)" by "IMO Resolutions A 694 (17), A 813 (19) and MSC 112(73)" in requirement [5.4.2].

Ch 10, Sec 7, [2.1.5]

Replace reference to "Pt D, Ch 7, Sec 6, [5.4.2] or Pt D, Ch 8, Sec 9, [2.3.1]" by a reference to (new) "Pt C, Ch 4, Sec 14, [13.3.2]".

Ch 10, Sec 10, [1.1.2] (Amendments July 2015)

Replace Note 1 by:

Note 1: According to Resolution MSC.137(76), these provisions are to be applied to ships of all rudder and propulsion types, of 100 m in length and over, and to chemical tankers and gas carriers regardless of the length, which were constructed on or after January 2004.

Ch 10, Sec 11, [4.3]

Replace requirement [4.3.1] by:

4.3.1 Specific arrangement for protection of deck machinery (foam monitors, davits, lifeboats, lifejackets lockers, winches, windlasses, cranes), helideck and its access, suppressing the risk of ice formation, such as machinery located in protected spaces, or specific protection arrangement preventing sea water spraying is to be provided.

Ch 10, Sec 14, [1.1]

Replace requirement [1.1.1] by:

1.1.1 This Section applies to ships having the service notation **liquefied gas carrier** or **LNG bunkering ship** and intended to carry methane (LNG) whose maximum cargo tank design pressure does not exceed 70 kPa and that are designed and built so as to allow the pressure in the tanks to increase above 25 kPa.

Chapter 10

Insert the following Section 20: (Amendments July 2015)

Insert the following Section 21:

SECTION 20 HELIDECK (HEL)

1 General

1.1 Application

1.1.1 The additional class notation **HEL** is assigned, in accordance with Pt A, Ch 1, Sec 2, [6.14.23], to ships fitted with helicopter facilities and complying with [1.2.1], in addition to the requirements from Part B and Part C, as applicable to helicopter facilities.

1.2 Reference standard

1.2.1 The design and arrangement of the helicopter facilities are to be in accordance with the Civil Aviation Publication 437 "Offshore Helicopter Landing Areas - Guidance on Standards" (CAP 437)".

SECTION 21 BATTERY SYSTEM

1 General

1.1 Application

1.1.1 The additional class notation **BATTERY SYSTEM** may be assigned to ships when batteries are used for propulsion and/or electric power supply purpose during ship operation. This notation is mandatory when the ship is relying only on batteries for propulsion and/or electrical power supply for main sources.

1.1.2 When an emergency source of power is required on board the ship, it is to remain independent from the battery source considered for propulsion and/or main source of power.

1.1.3 Batteries may be of the lead-acid type, nickel alkaline type or lithium type, due consideration being given to the suitability for any specific application. Other types of batteries may be considered (see [3.2.4]).

1.1.4 These requirements are supplementary to those mentioned in Pt C, Ch 2, Sec 7, Pt C, Ch 2, Sec 12, [5] and Pt C, Ch 4, Sec 11.

1.2 Documents to be submitted

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

2 Definitions and acronyms

2.1 System considered

2.1.1 The system considered is summarised in Fig 1.

2.2 Definitions

2.2.1 Battery management system (BMS)

A battery management system is an electronic system associated with a battery pack which monitors and/or manages in a safe manner its electric and thermal state by controlling its environment, and which provides communication between the battery system and other macro-system controllers, such as a power management system (PMS).

2.2.2 Battery pack

Battery pack means one or more sub-packs that can work or the intended purpose as a standalone unit.

2.2.3 Battery support system (BSS)

A battery support system is a group of interconnected and interactive parts that performs an essential task as a component of a battery system.

Note 1: Such systems are, for example, electrolyte circulation pumps, cooling and heating devices or fire extinguishers.

2.2.4 Battery system

A battery system is an energy storage device that includes cells, cell assemblies or battery pack(s), as well as electrical circuits and electronics (example of electronics: BMS, BSS, cell electronics).

2.2.5 Cell

Cell means the smallest unit of a battery.

2.2.6 Cell electronics

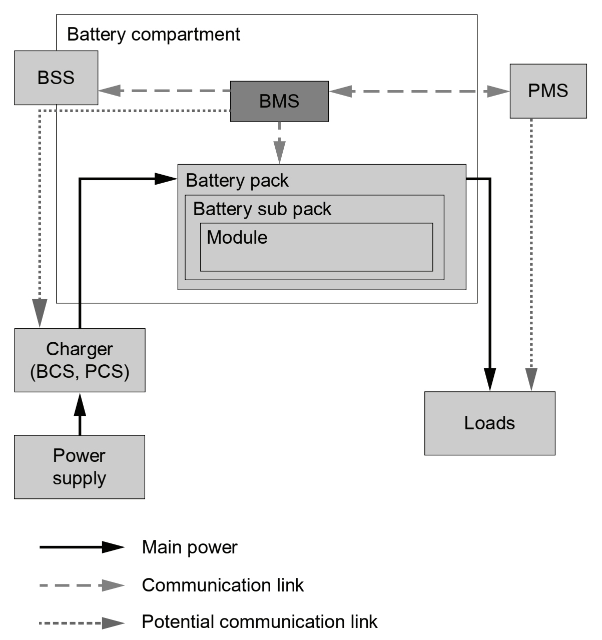
Cell electronics means the electronic device that collects and possibly monitors thermal and electric data of cells or cell assemblies and contains electronics for cell balancing, if necessary, as well as over-current protection devices (e.g. fuse).

Note 1: The cell electronics may include a cell controller. The functionality of cell balancing may be managed by the cell controller as part of a modular BMS.

2.2.7 Module

A module is an assembly of cells including some levels of electronic control.

Figure 1 : Battery system considered



This configuration shows only one battery pack. The battery pack may be duplicated inside the battery system.

BCS	:	Battery charging system
BSS	:	Battery support system
PCS	:	Power conversion system
PMS	:	Power management system
BMS	:	Battery management system.

Table 1 : Documents to be submitted

No.	A/I **(1)**	Document	Document details
1	A	Power balance	This document is to take into account the achievable configurations for energy production and distribution
2	A	Risk analysis when required (see [3.2.4])	This document is to consider together battery and BMS if any
3	A	Failure analysis regarding availability of ship propulsion and energy	
4	I	Information about toxic products present or likely to be produced in the battery system	
5	A	List of alarms and defaults	This list is to describe alarms and defaults directly connected to the battery system and interfaces with other ship systems, if any
6	A	Justification for choice of fire-extinguishing system	
7	I	Operation manual of battery and BMS	
8	A	Test programs related to type approval, factory test and onboard tests	
9	I	Reports related to test programs for type approval, factory test and onboard tests	
10	I	Standards used for design and testing procedures	If such standard is not available, the Manufacturer's specification is to be submitted
(1) A = to be submitted for approval I = to be submitted for information.			

2.2.8 Rated capacity

Rated capacity means Supplier's specification of the total amount of ampere hours that can be withdrawn from a fully charged battery pack or system for a specified set of test conditions, such as discharge rate, temperature and discharge cut-off voltage.

2.2.9 State of charge (SOC)

State of charge means the available capacity in a battery pack or system, used to estimate the current charge level of a battery in use.

2.2.10 State of health (SOH)

State of health means the available capacity in a battery pack or system as a function of the battery lifetime.

Note 1: SOC and SOH are expressed as percentages of rated capacity.

2.2.11 Sub-pack

Sub-pack means the assembly of one or more modules. This is the smallest unit that can be electrically isolated.

3 Safety and design issues

3.1 Battery compartment

3.1.1 Ventilation

Requirements mentioned in Pt C, Ch 2, Sec 11, [6] for large vented batteries are to be referred to. Additionally, when hazardous areas may be created regarding criteria of IEC 60079 series, the battery compartment and its neighbourhood is to be considered accordingly. In this case, a specific detection should be implemented, in order to monitor:

- negative pressure of the room
- ventilation air flow
- explosive or inflammable gas concentration. Detectors are to be positioned regarding air streams repartition in the battery compartment
- position of ventilation circuit valves.

When toxic products may be emitted in normal or abnormal conditions of operation, a specific analysis is to be undertaken (see [3.2.4]).

3.1.2 Protection against water entry and/or liquid leakage in battery compartment

It should not be possible to have sea water entering battery compartment.

The piping systems not involved in battery operation are not to be located in the battery compartment. Departure from this requirement may be accepted by the Society, with the following minimum conditions:

- efficient detection of fluid leakage is implemented in compartment
- pipes are provided with welded joints inside the battery compartment
- no flammable fluid is conveyed
- only class III pipes are accepted.

3.1.3 Protection against falling objects

Access hatches to batteries are to prevent falling of objects directly on battery cells, connections, elements of BMS, and cooling system if any.

3.1.4 Protection against electrostatic hazard

The battery room is to be painted with antistatic paintings in the circulating area.

3.1.5 Fire protection

The battery compartment boundaries are to be fitted with the thermal and structural subdivision corresponding to "Other machinery spaces". A-0 boundaries are to be fitted as a minimum between two battery compartments.

The battery compartment is to be fitted with a fixed gas fire-extinguishing system according to Part C, Chapter 4. The fluid employed is to be compatible with technology of the battery employed.

3.1.6 Accessibility for maintenance

It is to be possible to enter the battery compartment for common maintenance and to overhaul battery system elements in a safe manner.

3.2 Battery pack

3.2.1 Protection against ingress

IP rating of the batteries is to be fitted in relation with the location of the installation and the risk of ingress. The minimum required degree of protection is as follows:

- IP 2X for battery packs less than 1500 V DC
- IP 32 for battery packs more than 1500 V DC.

3.2.2 Lead-acid batteries, Ni-Cd batteries

The requirements mentioned in Pt C, Ch 2, Sec 7 apply for these type of batteries.

3.2.3 Lithium batteries

When lithium batteries are fitted, a risk analysis as mentioned in [3.2.4] is to be provided.

Lithium battery pack charging and un-charging are to be controlled with a BMS that is to be able:

- to monitor the battery pack state at the level at least of modules, sub-packs and packs regarding at least voltage, temperature, and, if necessary, to monitor current flow and detect leakage currents
- to estimate the potential need for battery pack or sub-pack connection or disconnection by determining if the battery pack or sub-pack is in a critical state, if there is a need coming from the PMS system or any other connected control system
- to control the proper connection and disconnection of the battery packs and sub-packs
- to optimise battery lifetime and energy availability by monitoring and controlling battery pack SOC and SOH, managing cells, sub-packs and packs balancing, and monitoring and controlling BSS.

3.2.4 Other types of batteries and risk analysis

Other types of batteries may be accepted by the Society. As for the lithium type batteries, a risk analysis covering together battery packs, battery compartment and BMS is to be conducted and submitted to the Society for review.

The following items, at least, are to be covered:

- risk of thermal runaway
- risk of emission of combustion gases
- risk of internal short-circuit
- risk of external short-circuit
- risk of sensor failure (voltage, temperature, gas sensor…)
- risk of high impedance (cell, connectors, …)
- risk of loss of cooling
- risk of leakage (electrolyte, cooling system)
- risk of failure of BMS (error on manoeuvring breakers, overloading, over discharge …)
- risk for external ingress (fire, fluid leakage, …).

Adequation of fire-extinguishing system to battery type should be documented.

Appropriate alarms and shutdown should be described (for example, default on the cooling system when necessary to proper operation of the battery system).

4 Availability of power

4.1 Ship configuration

4.1.1 The following cases are to be considered:

- Case 1: global battery system failure leads to loss of propulsion or of main electrical sources, see [4.2]
- Case 2: global battery system failure does not lead to any loss regarding ship propulsion and main source of power, see [4.3].

4.2 Case 1: global battery system failure leads to loss of propulsion or of main electrical sources

4.2.1 Types of ships

The ships falling onto SOLAS Convention cannot, from the Society point of view, be allowed to have configuration as mentioned in case 1.

4.2.2 Minimum requirements

The battery system is to be fitted with at least two independent packs of batteries to supply the main energy source.

A failure analysis taking into account single failure of the battery system and ability of the ship to reach a safe destination or to operate life-saving appliances and safety systems is to be provided.

If passengers, or cargoes falling onto consideration of MARPOL Convention, are transported, it is to be possible to steer and manoeuvre the ship with one battery pack unavailable.

4.3 Case 2: global battery system failure does not lead to any loss regarding ship propulsion and main source of power

4.3.1 Types of ships

It is reminded that flag agreement needs to be obtained for statutory compliance, especially regarding method to obtain compliance with SOLAS Convention.

In case where a ship is not complying with SOLAS Convention when the battery system is not taken into account, requirements [4.3.2] and [4.3.3] are to be considered.

4.3.2 Minimum requirements

The requirements mentioned in [4.2.2] are to be complied with.

4.3.3 Additional requirements for compliance to SOLAS Convention from the Society point of view

When the battery pack is supposed to replace the main energy source and the propulsion energy source, it is to be able to provide energy for 8-hour operations, as mentioned in Pt C, Ch 1, Sec 10, [11].

5 Test and certification process for batteries

5.1 Battery cells

5.1.1 Scheme of approval

Battery cells are to be type approved according to scheme H_{BV} as described in NR320, Certification Scheme of Materials and Equipment for the Classification of Marine Units. See Tab 2.

5.1.2 Prototype tests

Battery cell prototype tests are to refer to a National or International standard. If such a standard is not available, the Manufacturer's specifications are to be submitted to the Society.

The following items, at least, are to be checked:

- behaviour of the cell when the battery cell is getting out of specification (high and low limits of tension, high limit of current, gas production, thermal runaway, …)
- capacity of cell regarding temperature and un-loading current
- insulation
- IP characteristics
- other items raised by risk assessment
- applicable requirements of IACS UR E10.

5.1.3 Factory acceptance tests

Factory acceptance tests for battery cells are to refer to a National or International standard. If such a standard is not available, the Manufacturer's specifications are to be submitted to the Society. These pieces of documentation are to be identified at the time of type approval. The following items, at least, are to be checked:

- insulation
- IP characteristics.

5.1.4 Onboard test

Battery cell test in itself is to be included in the battery pack test.

5.2 Equipment used in battery systems

5.2.1 Approval and testing of pieces of equipment, such as safety electrical equipment, fuses, over current protective devices, circuit breakers, contractors and cables, are to follow the requirements mentioned in Part C, Chapter 2 and NR266, Requirements for Survey of Materials and Equipment for the Classification of Ships and Offshore Units.

5.3 Battery packs and associated BMS

5.3.1 Scheme of approval

Battery packs are to be type approved according to scheme I_{BV} as described in NR320 (see Tab 2). When a battery pack is installed with a BMS, the type approval is to cover battery pack and BMS. A case-by-case approval can be applied with the same review and testing as for the type approval scheme.

Table 2 : Schemes of approval

Item	Product certification				Remarks
	Design assessment/ Approval **(1)**	Raw material certificate	Examination and testing	Product certificate **(2)**	
Battery Cell	TA (H_{BV})		X (see [5.1])	W	
Battery pack and associated BMS	TA (I_{BV})		X (see [5.3])	C	

(1) TA (H_{BV}) : Type Approval is required with work's recognition (H_{BV} scheme as per NR320)
TA (I_{BV}) : Type Approval is required with work's recognition (I_{BV} scheme as per NR320).
(2) W indicates that a Manufacturer's certificate is required.
C indicates that a product certificate of the Society is required with invitation of the Surveyor to attend the tests, unless otherwise agreed.

5.3.2 Prototype tests

Battery pack prototype tests are to refer to a National or International standard. If such a standard is not available, the Manufacturer's specifications are to be submitted to the Society. These pieces of documentation are to be identified at the time of type approval.

The following items, at least, are to be checked:

- ability to achieve safety functions
- proper working of alarms and defaults and related functions and/or interfacing to the other ship systems
- proper working of monitoring systems
- ability to provide optimised battery life time and availability
- IP characteristics
- other items raised by risk assessment
- applicable requirements of IACS UR E10.

5.3.3 Factory acceptance tests

Factory acceptance tests for battery packs are to refer to a National or International standard. If such a standard is not available, the Manufacturer's specifications are to be submitted to the Society.

The following items, at least, are to be checked:

- ability to achieve safety functions
- proper working of alarms and defaults and related functions and/or interfacing to the other ship systems
- proper working of monitoring systems
- insulation
- IP characteristics.

5.3.4 Onboard tests

Onboard tests for battery packs are to refer to a National or International standard. If such a standard is not available, the Manufacturer's specifications are to be submitted to the Society.

The following items, at least, are to be checked:

- proper working of alarms and defaults and related functions and/or interfacing to the other ship systems
- proper working of monitoring systems
- fitting of battery pack arrangement to battery compartment
- battery capacity and loading duration, at least for the cases mentioned in the ship availability failure analysis
- insulation
- IP characteristics.

5.4 Onboard tests of battery compartment and fire-extinguishing system

5.4.1 Fire detection

Efficiency of fire detection is to be tested.

5.4.2 Dangerous gas detection

Efficiency of dangerous gas detection is to be tested. This includes testing that detectors were properly positioned to detect dangerous gas concentration in any normal circumstance of operation of the ventilation system.

5.4.3 Fire-extinguishing system efficiency

Efficiency of fire-extinguishing system is to be tested. Gas concentration after fire-extinguishing system operation is to be measured and found high enough to prevent an explosion or stop a fire. Other criteria may be defined or asked for, at the satisfaction of the Society.

5.4.4 Accessibility of battery compartment

Accessibility for common maintenance and devices used for battery overhaul, if any, are to be tested.